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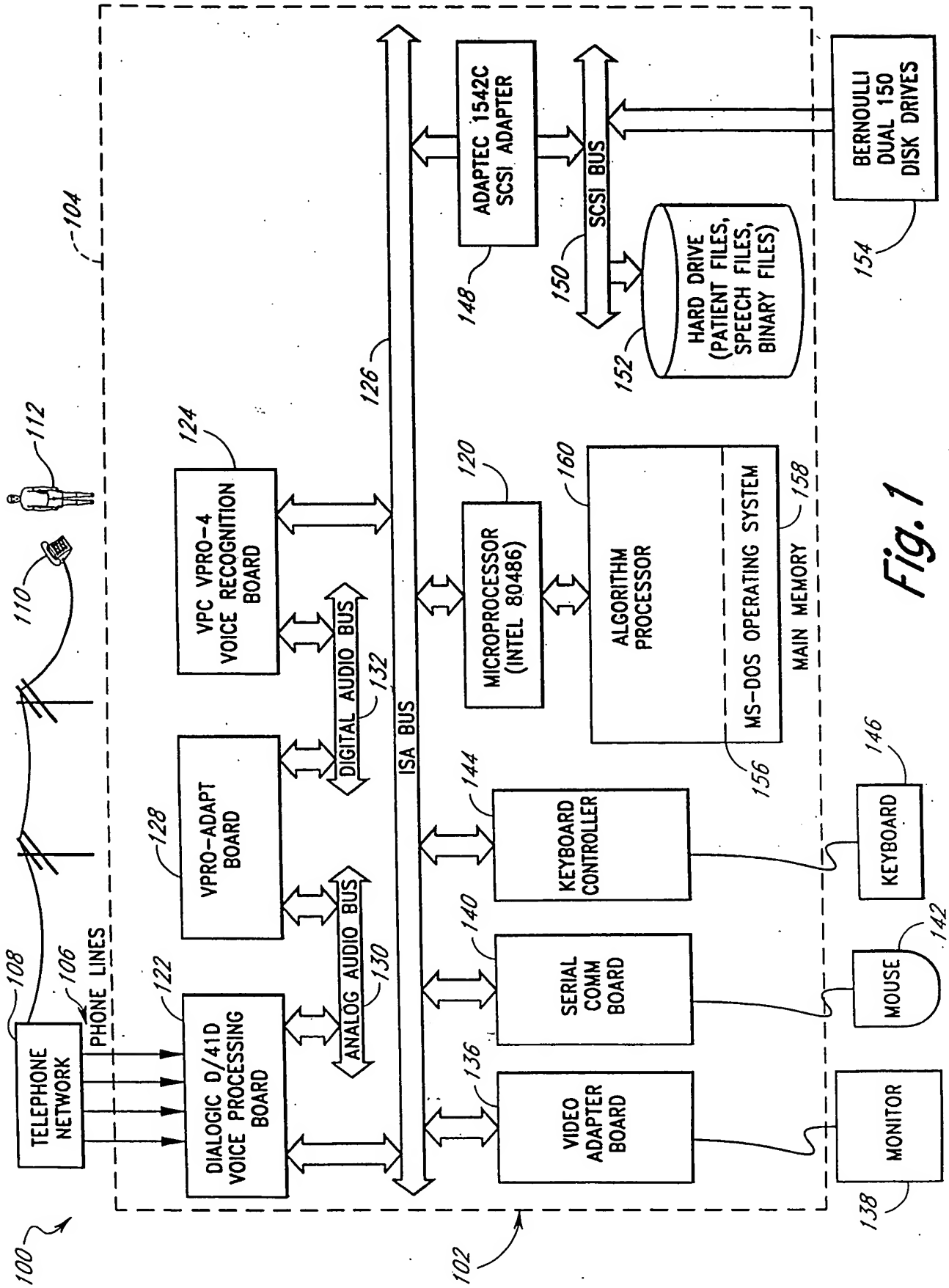
100
102
104
106
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112
120
122
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126
128
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138
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142
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146
148
150
152
154
156
158
160
TELEPHONE NETWORK
PHONE LINES
DIALOGIC D/41D VOICE PROCESSING BOARD
VPRO-ADAPT BOARD
VPC VPRO-4 VOICE RECOGNITION BOARD
ANALOG AUDIO BUS
DIGITAL AUDIO BUS
ISA BUS
MICROPROCESSOR (INTEL 80486)
ALGORITHM PROCESSOR
MS-DOS OPERATING SYSTEM
MAIN MEMORY
ADAPTEC 1542C SCSI ADAPTER
SCSI BUS
HARD DRIVE (PATIENT FILES, SPEECH FILES, BINARY FILES)
BERNOULLI DUAL 150 DISK DRIVES
KEYBOARD CONTROLLER
KEYBOARD
SERIAL COMM BOARD
MOUSE
VIDEO ADAPTER BOARD
MONITOR

Fig. 1

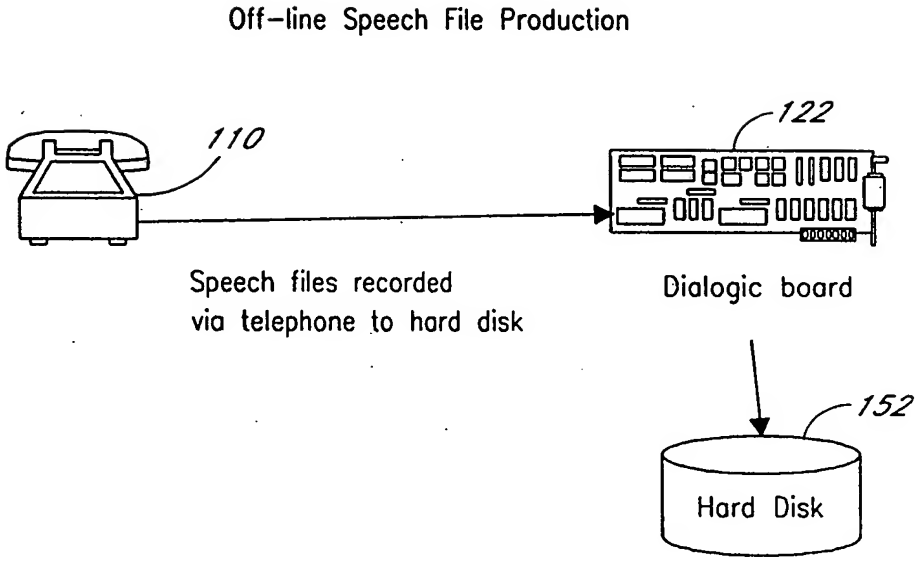
Off-line Speech File Production
110
122
Speech files recorded
via telephone to hard disk
Dialogic board
152
Hard Disk

Fig.2

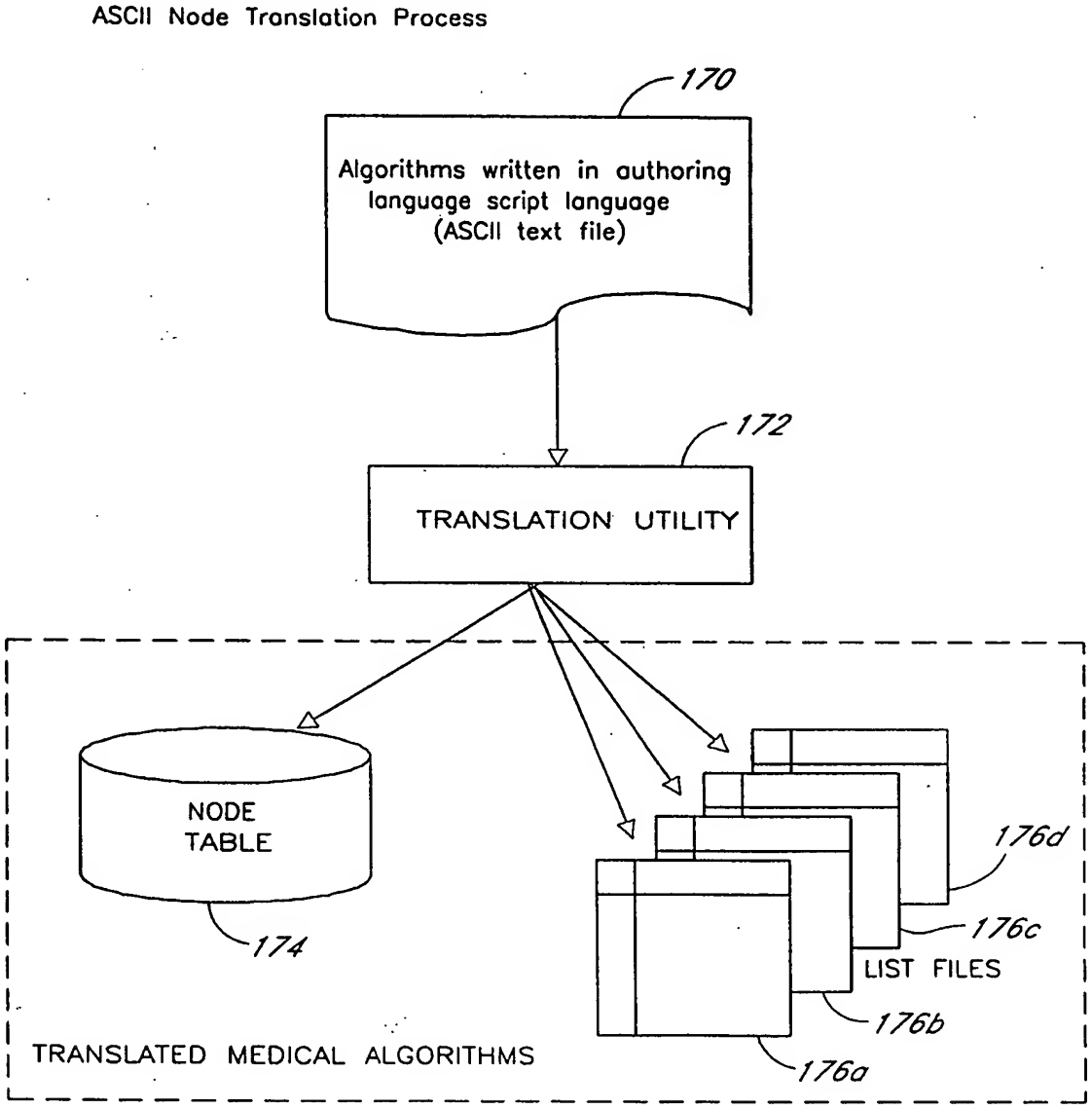
ASCII Node Translation Process
170
Algorithms written in authoring language script language (ASCII text file)
172
TRANSLATION UTILITY
NODE TABLE
174
176d
176c
LIST FILES
176b
176a
TRANSLATED MEDICAL ALGORITHMS

Fig. 3

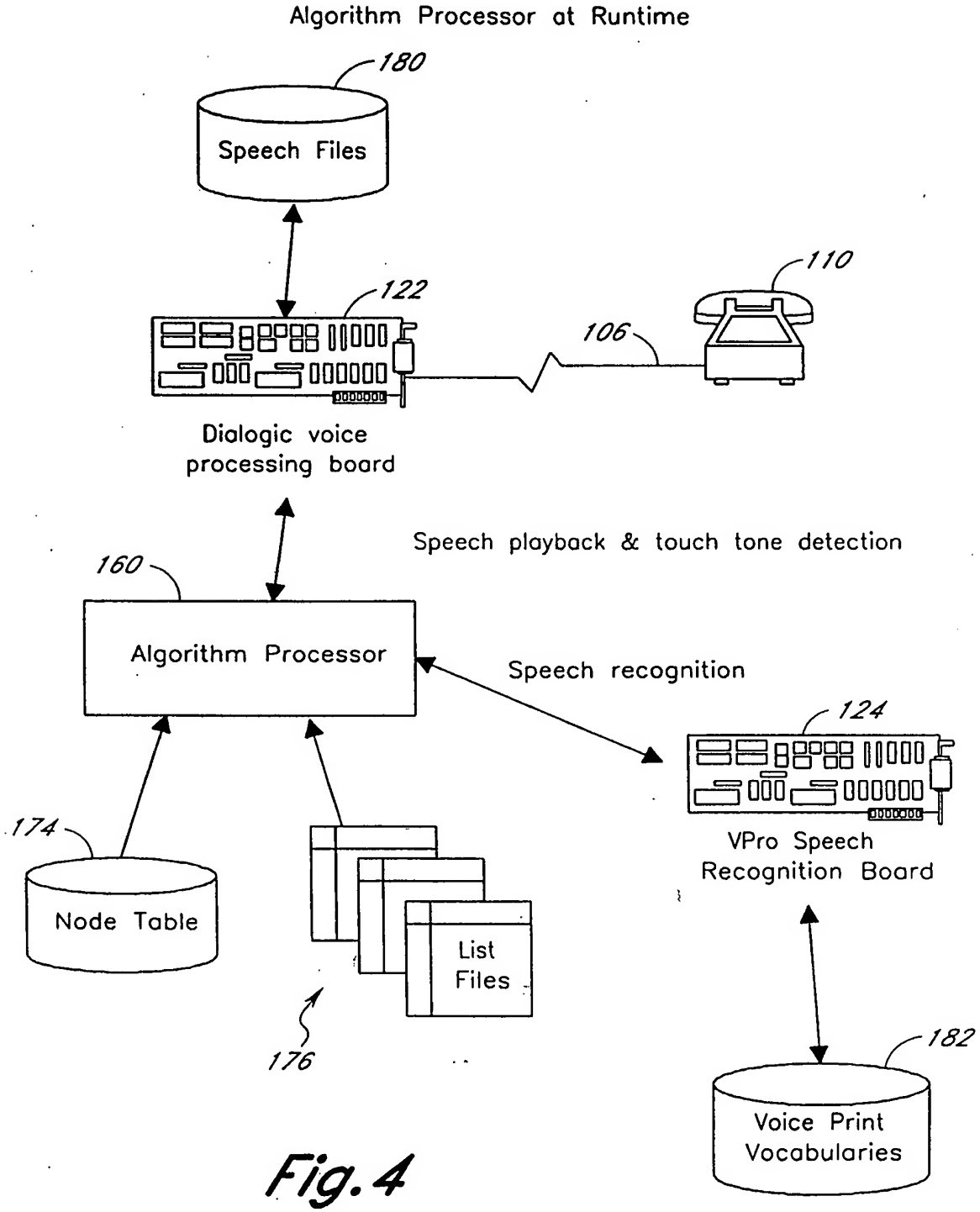
Algorithm Processor at Runtime
180
Speech Files
122
110
106
Dialogic voice
processing board
Speech playback & touch tone detection
160
Algorithm Processor
Speech recognition
124
VPro Speech
Recognition Board
174
Node Table
List
Files
176
182
Voice Print
Vocabularies

Fig. 4

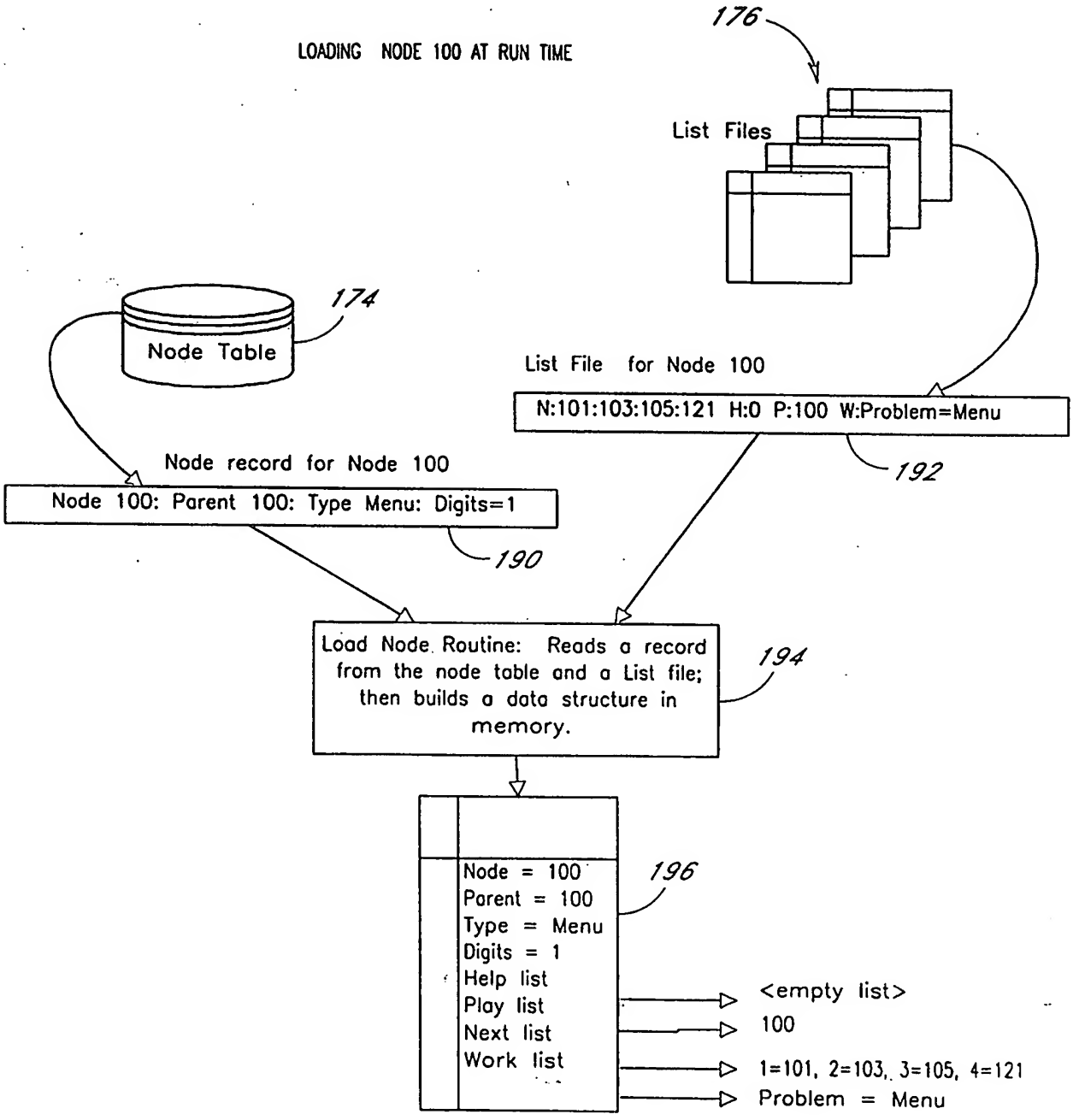
LOADING NODE 100 AT RUN TIME
176
List Files
174
Node Table
List File for Node 100
N:101:103:105:121 H:0 P:100 W:Problem=Menu
192
Node record for Node 100
Node 100: Parent 100: Type Menu: Digits=1
190
Load Node Routine: Reads a record from the node table and a List file; then builds a data structure in memory.
194
Node = 100
Parent = 100
Type = Menu
Digits = 1
Help list
Play list
Next list
Work list
196
<empty list>
100
1=101, 2=103, 3=105, 4=121
Problem = Menu

Fig. 5a

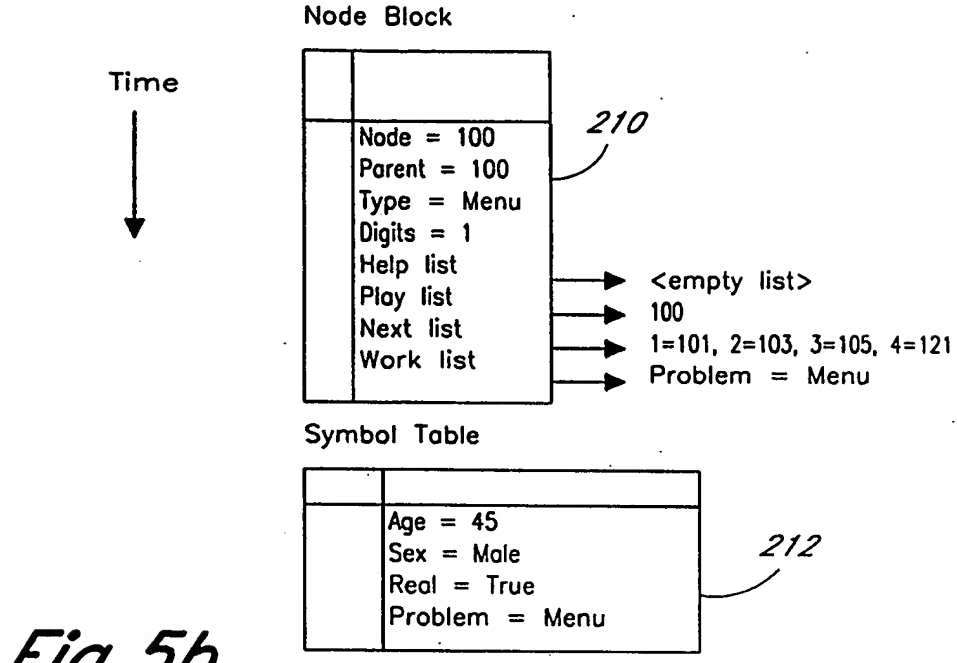
Node Block
Time
Node = 100
Parent = 100
Type = Menu
Digits = 1
Help list
Play list
Next list
Work list
210
<empty list>
100
1=101, 2=103, 3=105, 4=121
Problem = Menu
Symbol Table
Age = 45
Sex = Male
Real = True
Problem = Menu
212

Fig. 5b

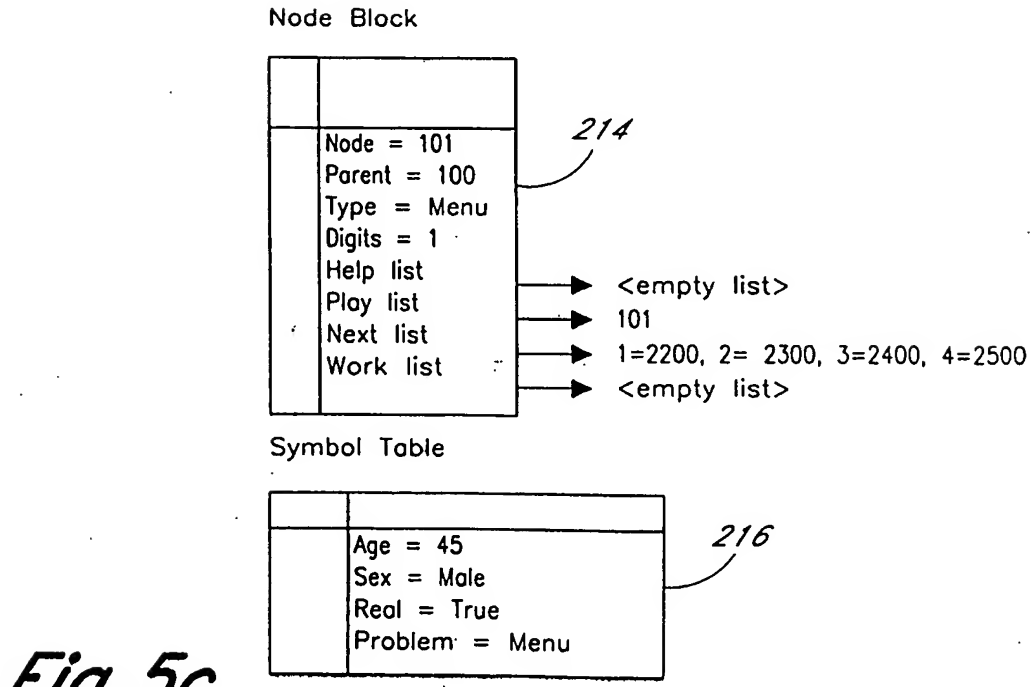
Node Block
Node = 101
Parent = 100
Type = Menu
Digits = 1
Help list
Play list
Next list
Work list
214
<empty list>
101
1=2200, 2= 2300, 3=2400, 4=2500
<empty list>
Symbol Table
Age = 45
Sex = Male
Real = True
Problem = Menu
216

Fig. 5c

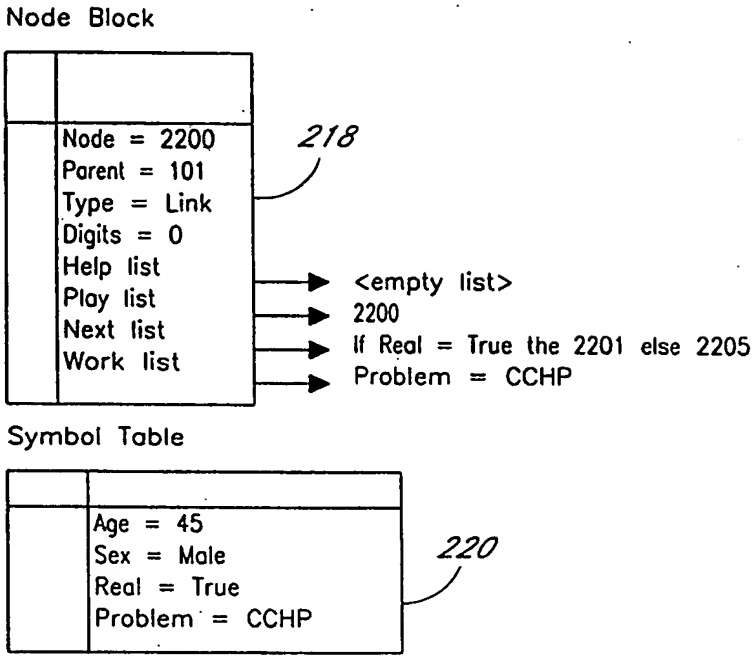
Node Block
Node = 2200
Parent = 101
Type = Link
Digits = 0
Help list
Play list
Next list
Work list
218
<empty list>
2200
If Real = True the 2201 else 2205
Problem = CCHP
Symbol Table
Age = 45
Sex = Male
Real = True
Problem = CCHP
220

Fig. 5d

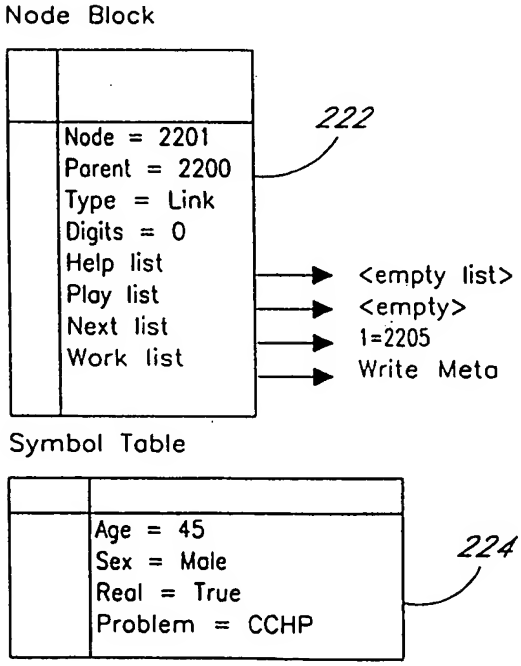
Node Block
Node = 2201
Parent = 2200
Type = Link
Digits = 0
Help list
Play list
Next list
Work list
222
<empty list>
<empty>
1=2205
Write Meta
Symbol Table
Age = 45
Sex = Male
Real = True
Problem = CCHP
224

Fig. 5e

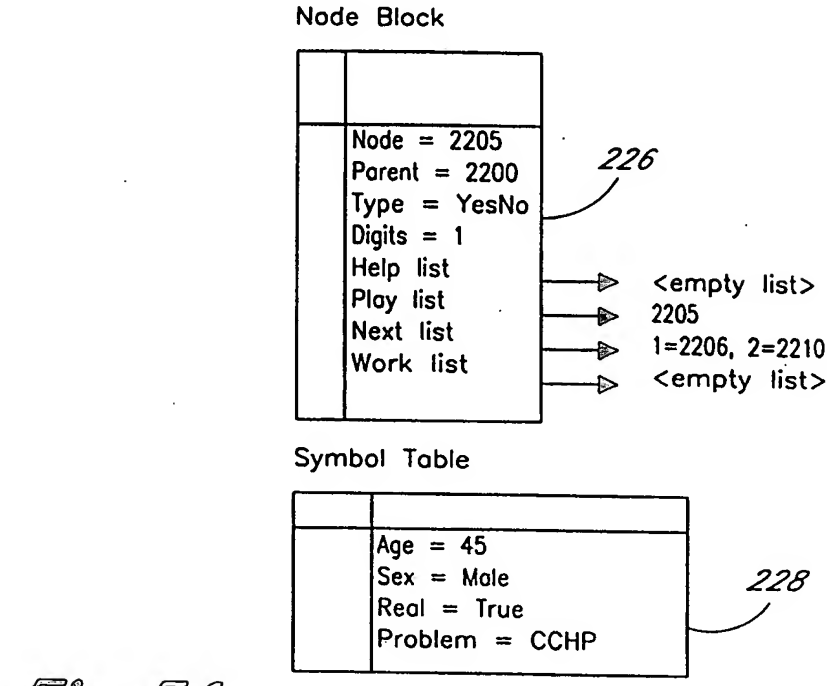
Node Block
Node = 2205
Parent = 2200
Type = YesNo
Digits = 1
Help list
Play list
Next list
Work list
226
<empty list>
2205
1=2206, 2=2210
<empty list>
Symbol Table
Age = 45
Sex = Male
Real = True
Problem = CCHP
228

Fig. 5f

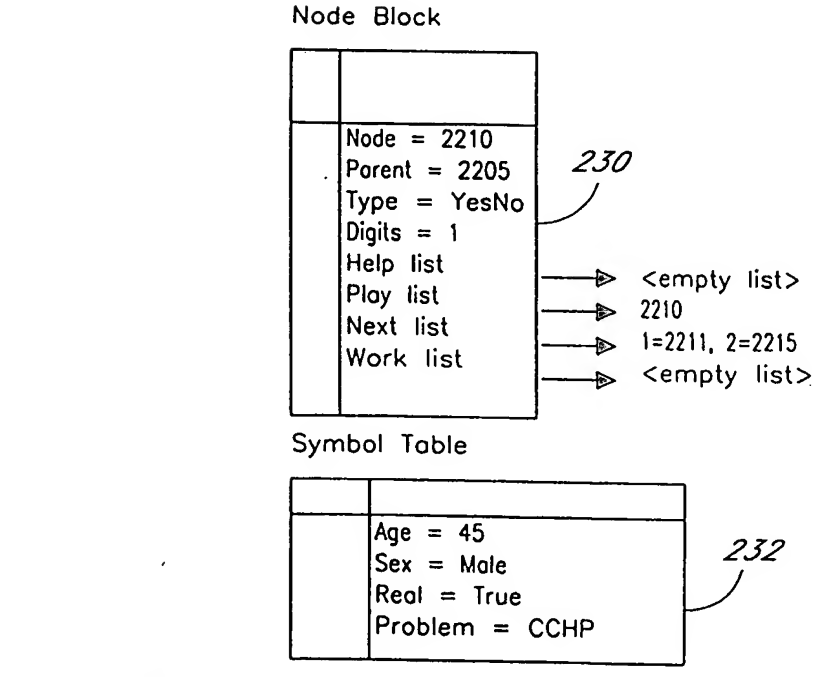
Node Block
Node = 2210
Parent = 2205
Type = YesNo
Digits = 1
Help list
Play list
Next list
Work list
230
<empty list>
2210
1=2211, 2=2215
<empty list>
Symbol Table
Age = 45
Sex = Male
Real = True
Problem = CCHP
232

Fig. 5g

Software Conceptual Diagram

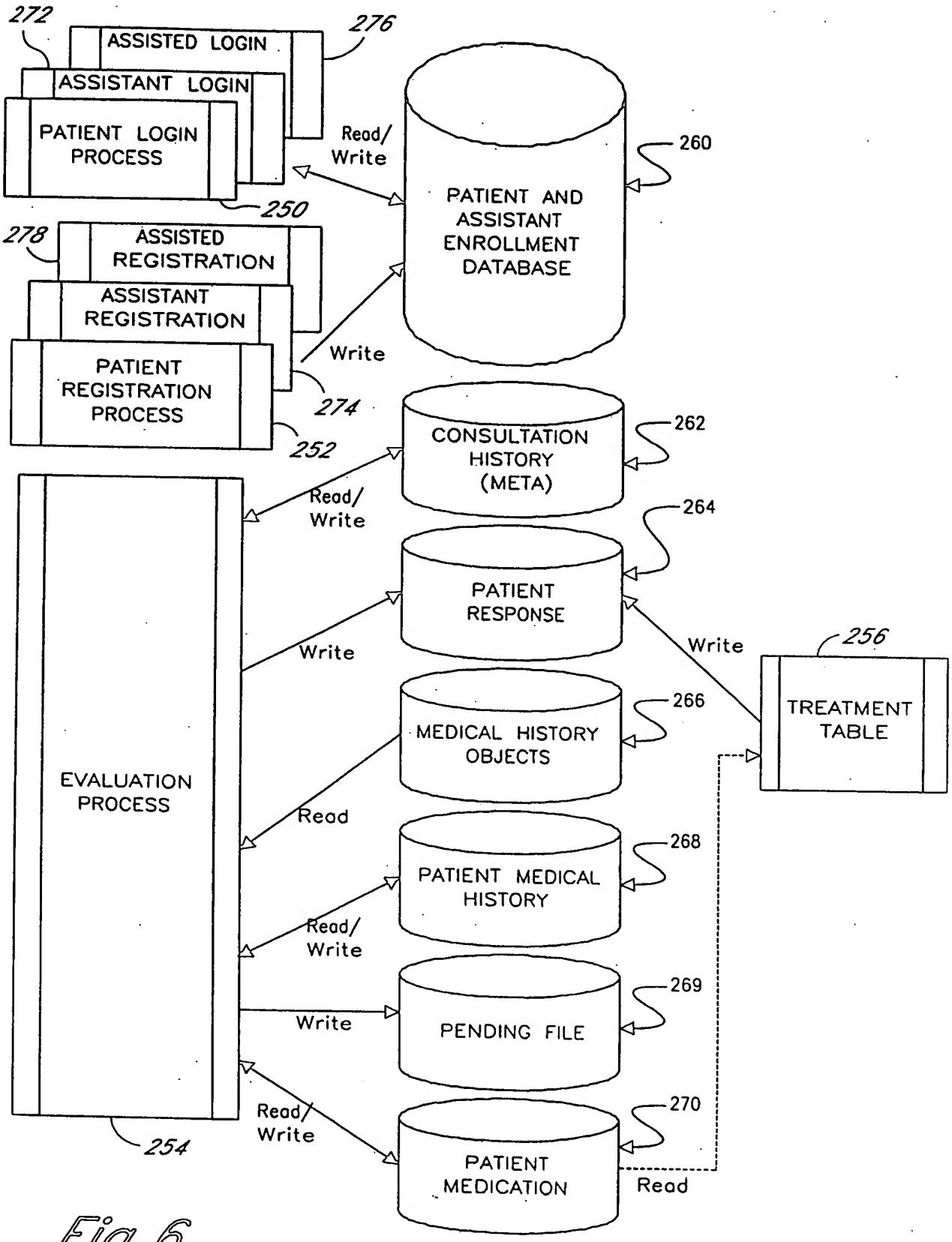

Fig. 6

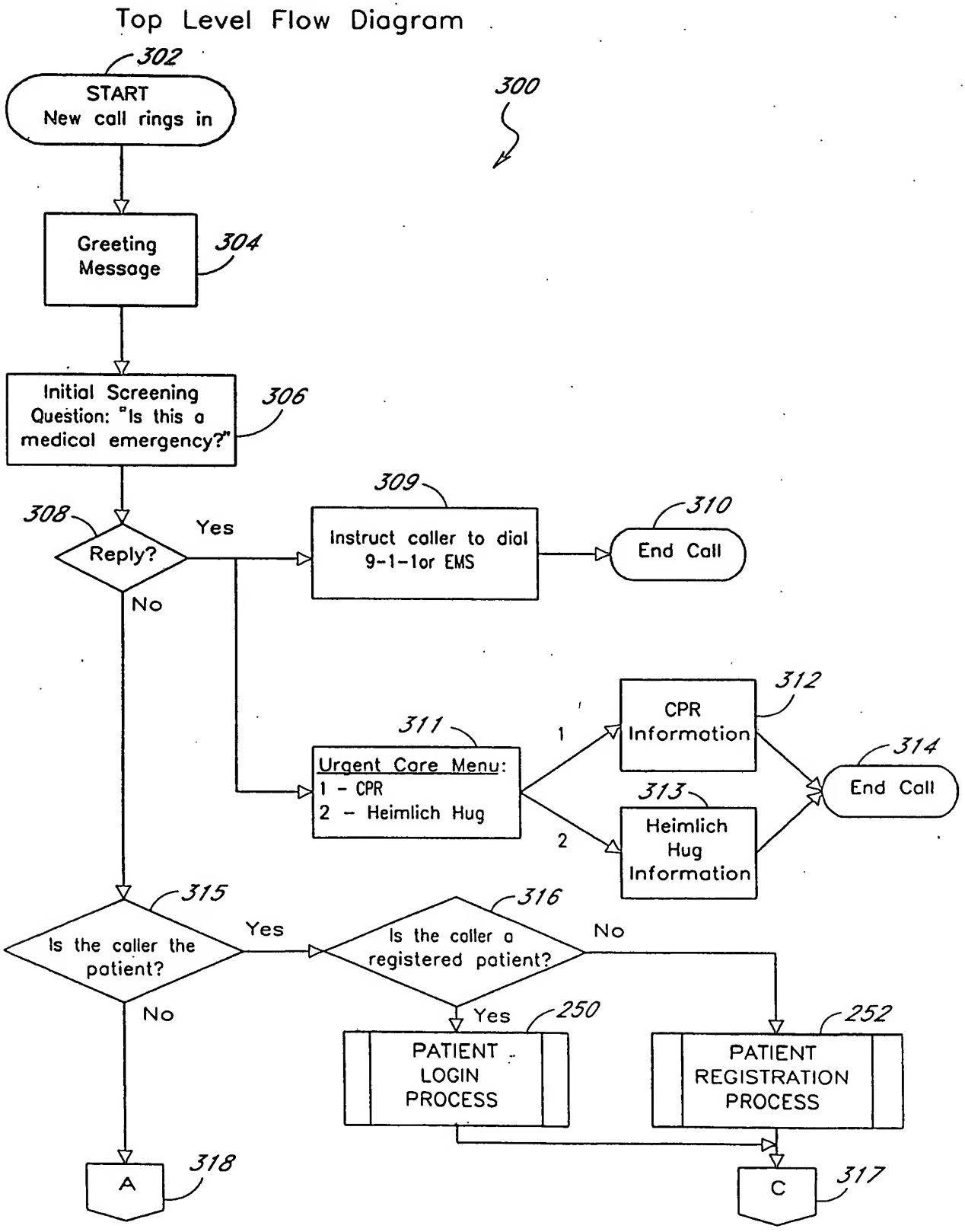
Top Level Flow Diagram
300
302
START
New call rings in
304
Greeting Message
306
Initial Screening Question: "Is this a medical emergency?"
308
Reply?
Yes
No
309
Instruct caller to dial 9-1-1or EMS
310
End Call
311
Urgent Care Menu:
1 - CPR
2 - Heimlich Hug
1
2
312
CPR Information
313
Heimlich Hug Information
314
End Call
315
Is the caller the patient?
Yes
No
316
Is the caller a registered patient?
Yes
No
250
PATIENT LOGIN PROCESS
252
PATIENT REGISTRATION PROCESS
318
A
317
C

Fig. 7a

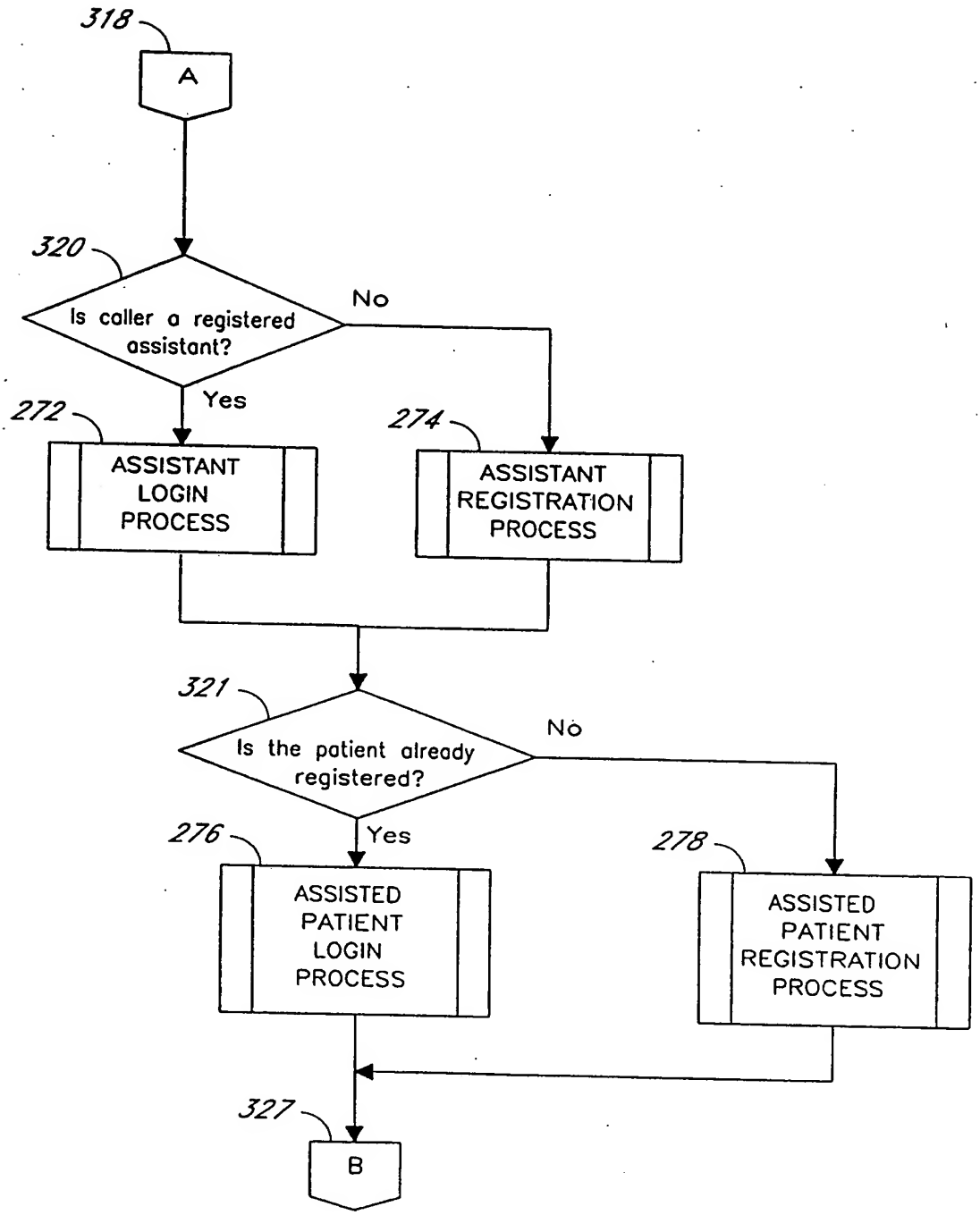
318
A
320
Is caller a registered assistant?
No
Yes
272
ASSISTANT LOGIN PROCESS
274
ASSISTANT REGISTRATION PROCESS
321
Is the patient already registered?
No
Yes
276
ASSISTED PATIENT LOGIN PROCESS
278
ASSISTED PATIENT REGISTRATION PROCESS
327
B

Fig. 7b

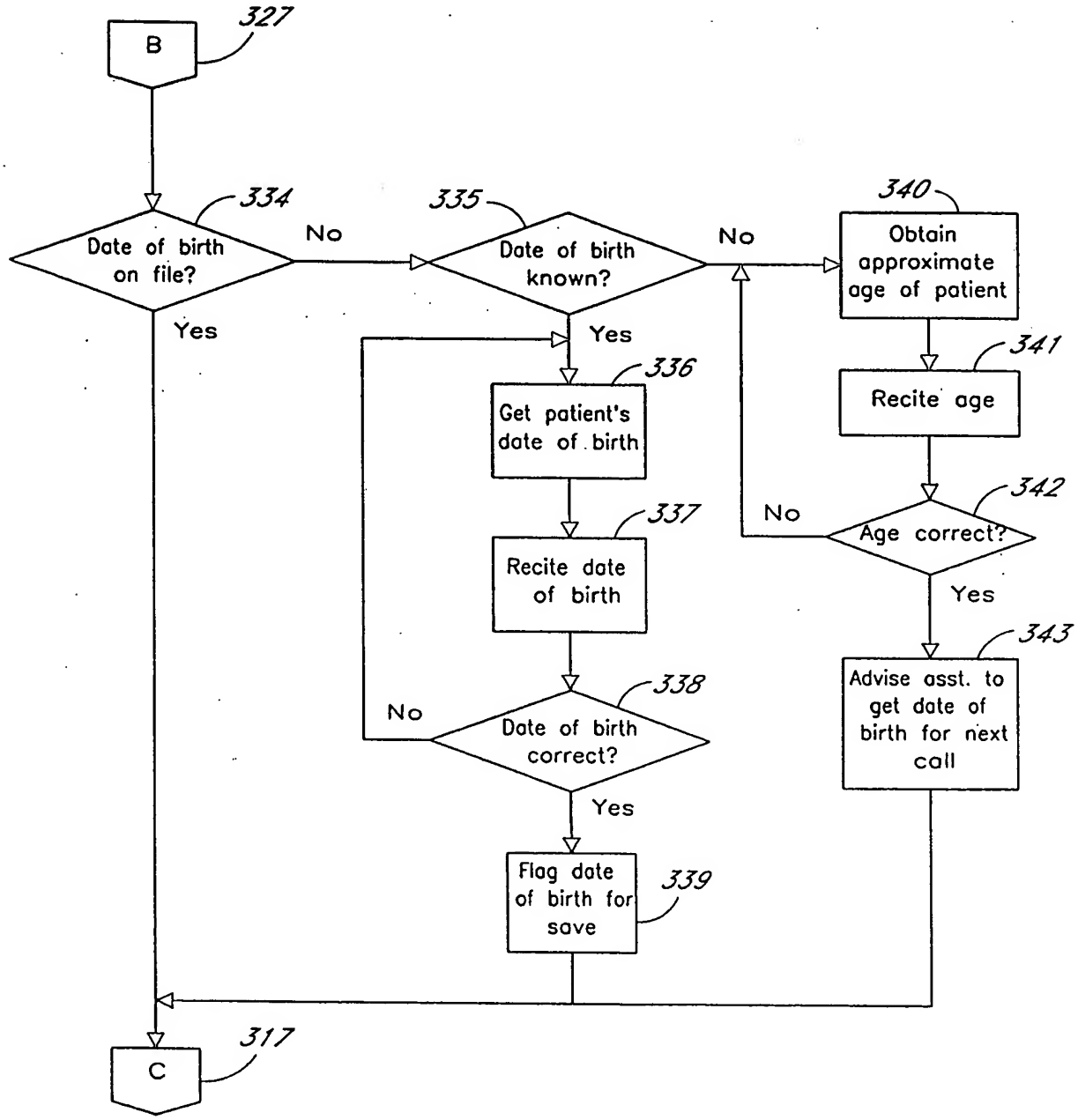
B
327
Date of birth on file?
334
No
Yes
Date of birth known?
335
No
Yes
Get patient's date of birth
336
Recite date of birth
337
Date of birth correct?
338
No
Yes
Flag date of birth for save
339
Obtain approximate age of patient
340
Recite age
341
Age correct?
342
No
Yes
Advise asst. to get date of birth for next call
343
C
317

Fig. 7c

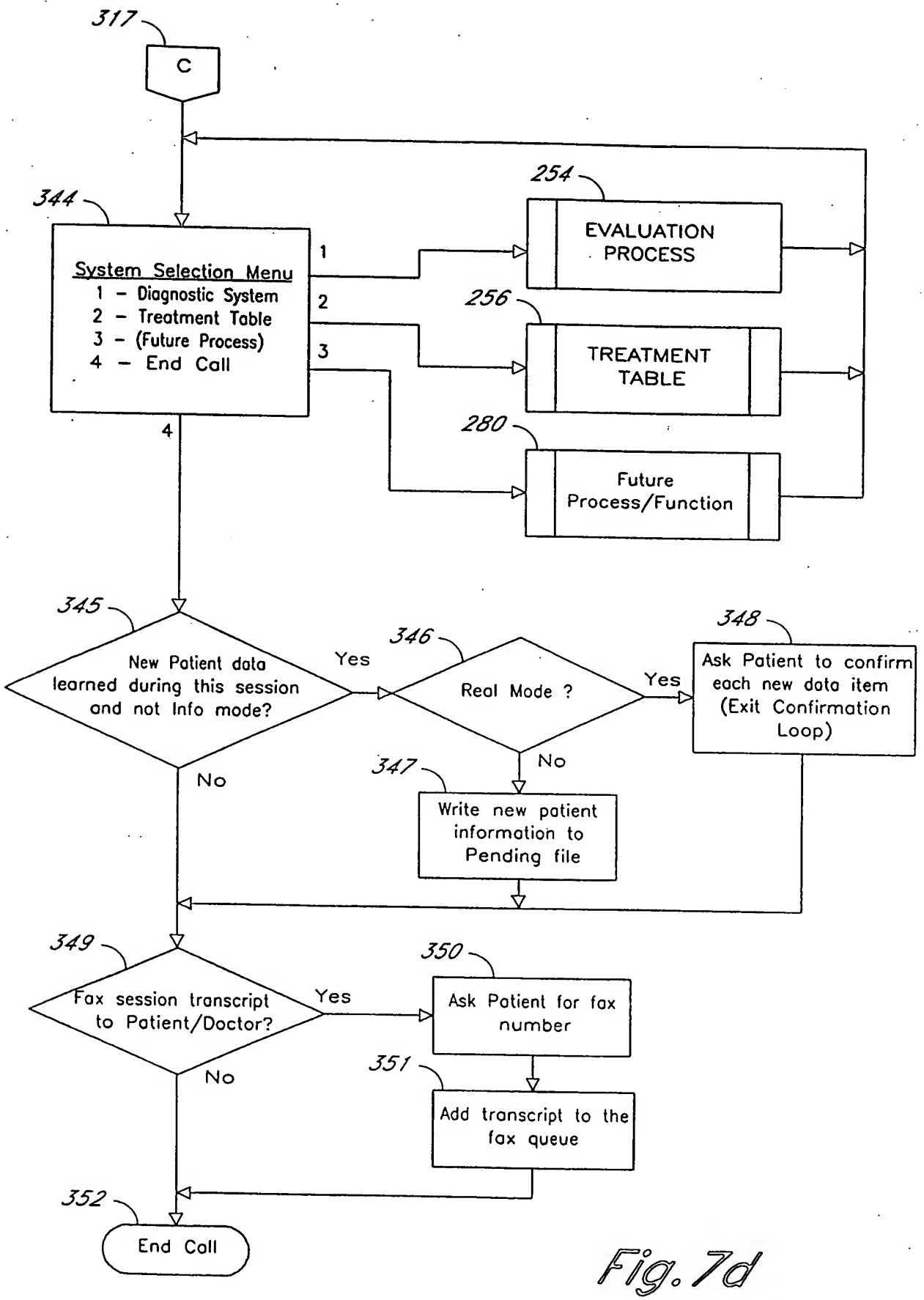
317
C
344
System Selection Menu
1 - Diagnostic System
2 - Treatment Table
3 - (Future Process)
4 - End Call
1
2
3
4
254
EVALUATION PROCESS
256
TREATMENT TABLE
280
Future Process/Function
345
New Patient data learned during this session and not Info mode?
Yes
No
346
Real Mode ?
Yes
No
348
Ask Patient to confirm each new data item (Exit Confirmation Loop)
347
Write new patient information to Pending file
349
Fax session transcript to Patient/Doctor?
Yes
No
350
Ask Patient for fax number
351
Add transcript to the fax queue
352
End Call

Fig. 7d

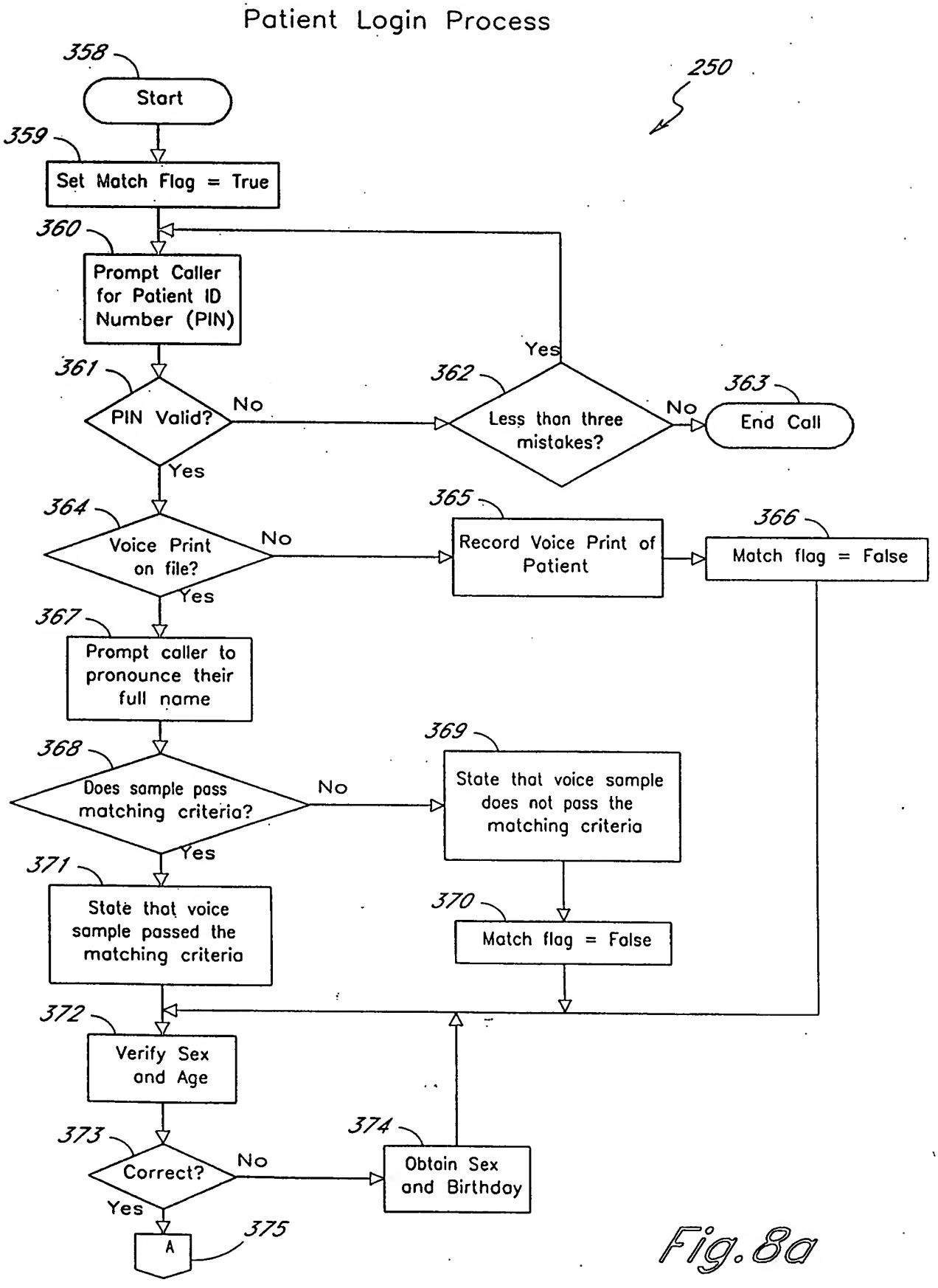
Patient Login Process
250
358
Start
359
Set Match Flag = True
360
Prompt Caller for Patient ID Number (PIN)
361
PIN Valid?
No
Yes
362
Less than three mistakes?
Yes
No
363
End Call
364
Voice Print on file?
No
Yes
365
Record Voice Print of Patient
366
Match flag = False
367
Prompt caller to pronounce their full name
368
Does sample pass matching criteria?
No
Yes
369
State that voice sample does not pass the matching criteria
370
Match flag = False
371
State that voice sample passed the matching criteria
372
Verify Sex and Age
373
Correct?
No
Yes
374
Obtain Sex and Birthday
375
A

Fig. 8a

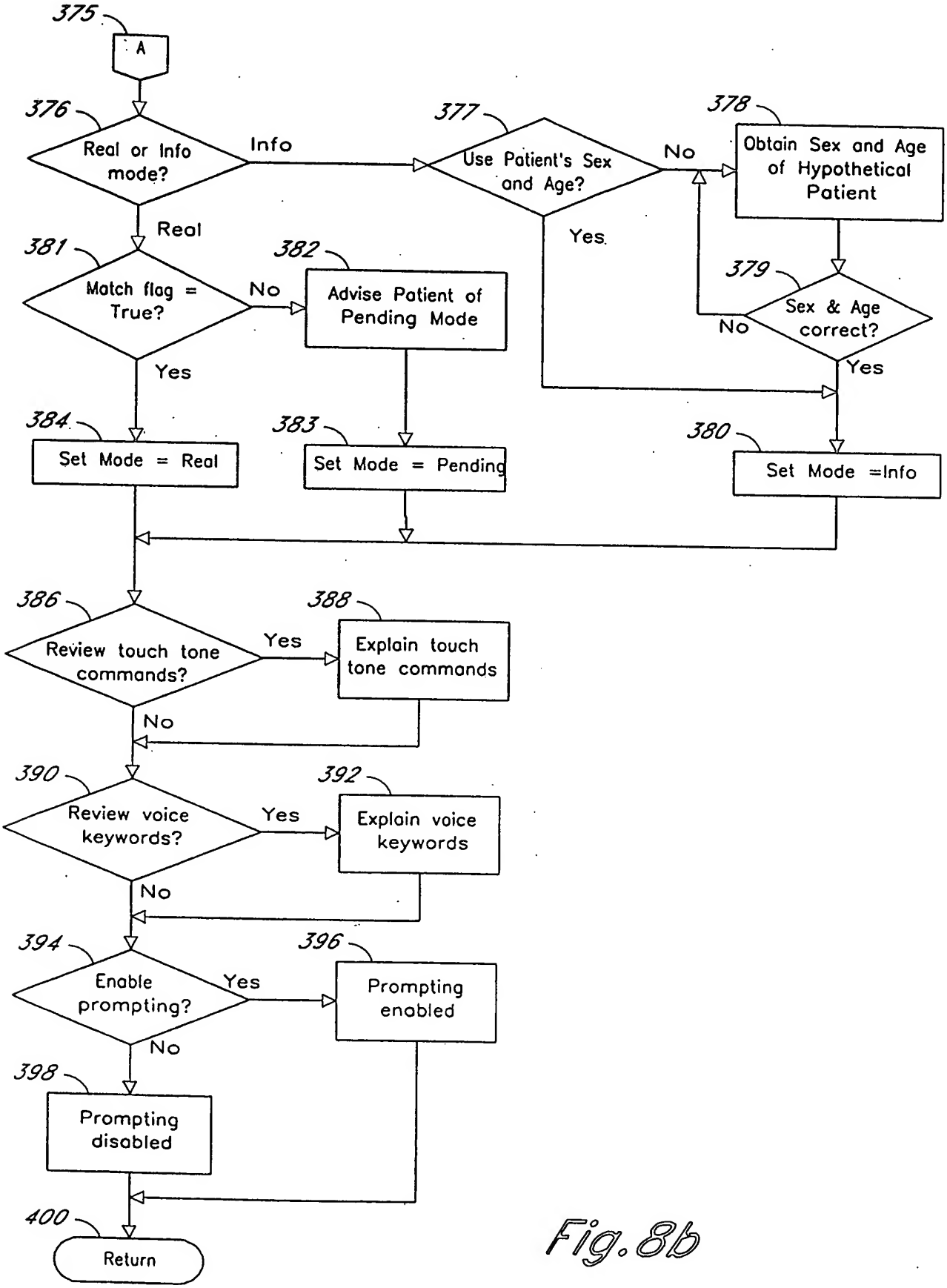
375
A
376
Real or Info mode?
Info
Real
377
Use Patient's Sex and Age?
No
Yes
378
Obtain Sex and Age of Hypothetical Patient
379
Sex & Age correct?
No
Yes
381
Match flag = True?
No
Yes
382
Advise Patient of Pending Mode
384
Set Mode = Real
383
Set Mode = Pending
380
Set Mode =Info
386
Review touch tone commands?
Yes
No
388
Explain touch tone commands
390
Review voice keywords?
Yes
No
392
Explain voice keywords
394
Enable prompting?
Yes
No
396
Prompting enabled
398
Prompting disabled
400
Return

Fig. 8b

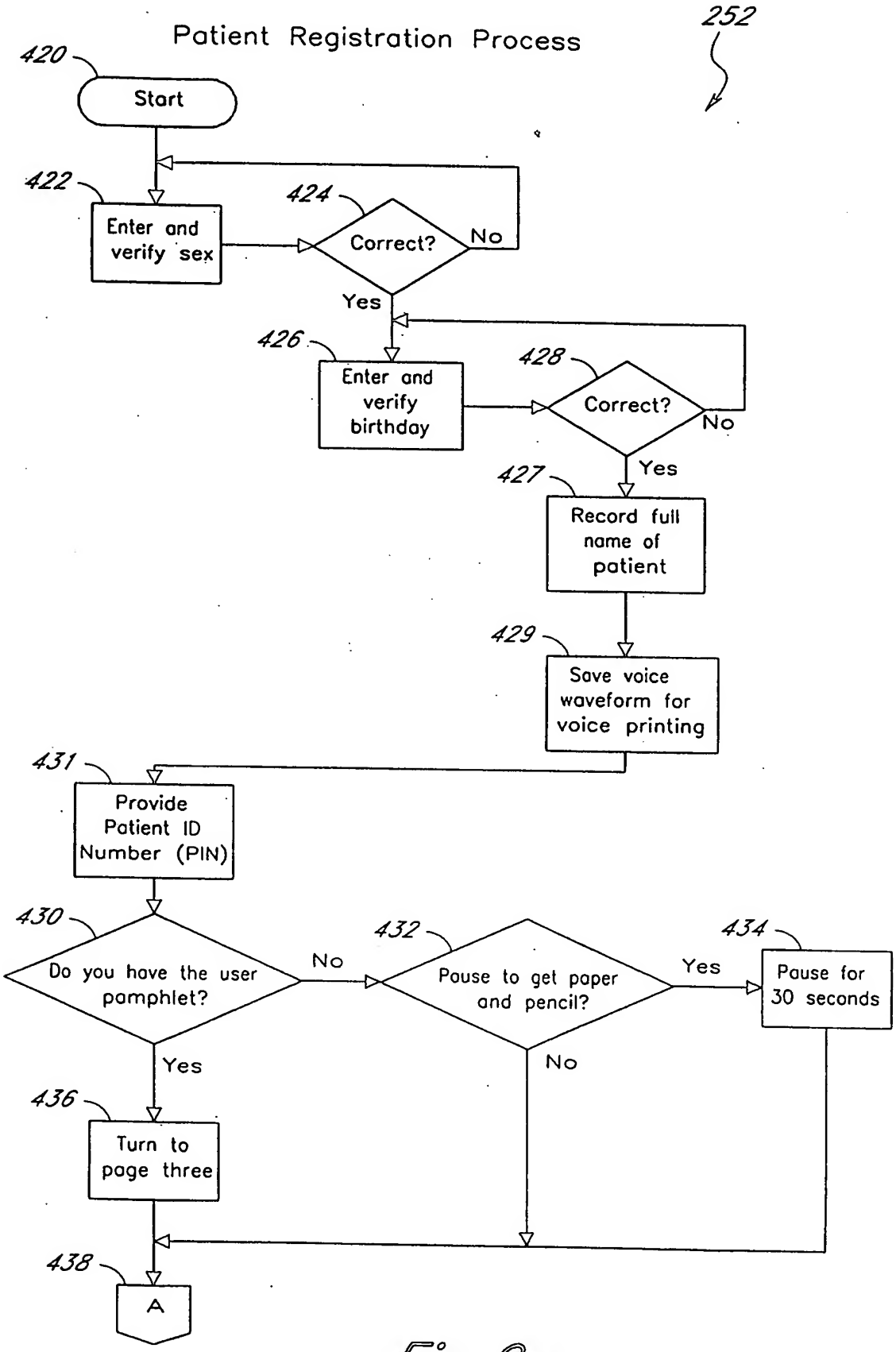
Patient Registration Process
252
420
Start
422
Enter and verify sex
424
Correct?
No
Yes
426
Enter and verify birthday
428
Correct?
No
Yes
427
Record full name of patient
429
Save voice waveform for voice printing
431
Provide Patient ID Number (PIN)
430
Do you have the user pamphlet?
No
432
Pause to get paper and pencil?
Yes
434
Pause for 30 seconds
Yes
No
436
Turn to page three
438
A

Fig. 9a

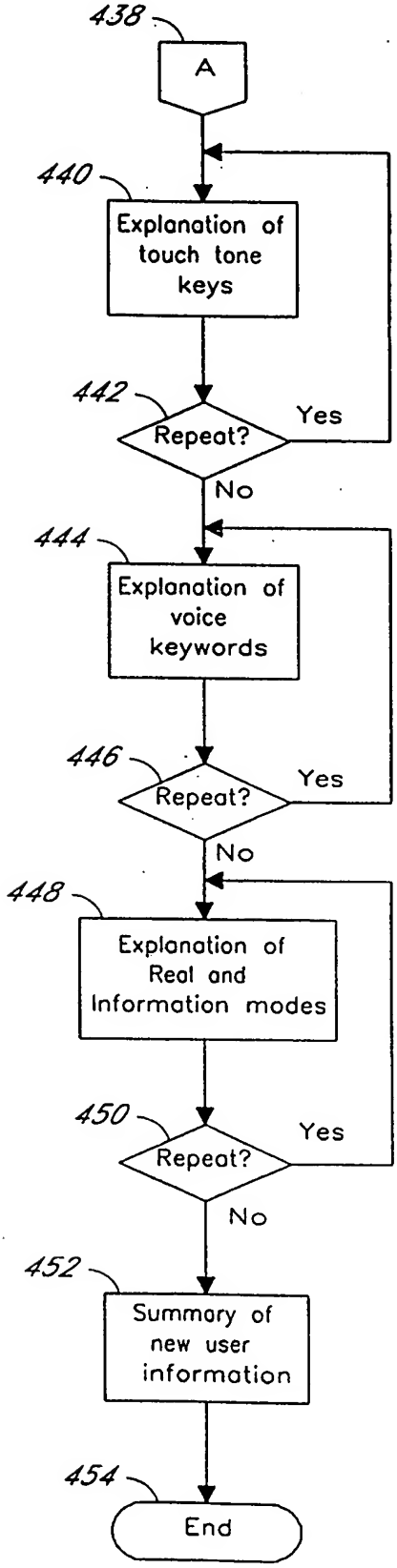
438
A
440
Explanation of touch tone keys
442
Repeat?
Yes
No
444
Explanation of voice keywords
446
Repeat?
Yes
No
448
Explanation of Real and Information modes
450
Repeat?
Yes
No
452
Summary of new user information
454
End

Fig. 9b

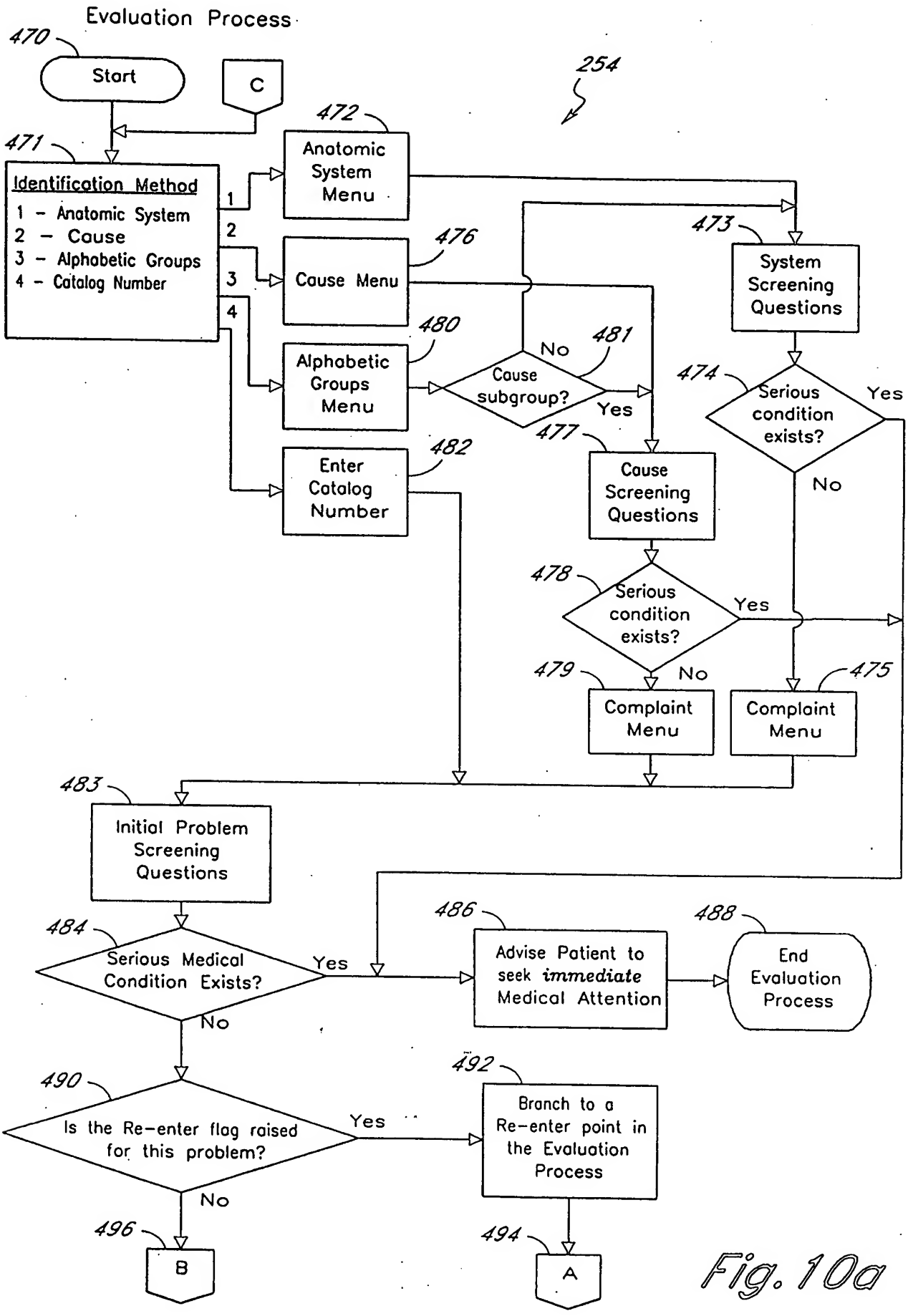
Evaluation Process
470
Start
C
254
472
Anatomic System Menu
471
Identification Method
1 - Anatomic System
2 - Cause
3 - Alphabetic Groups
4 - Catalog Number
1
2
3
4
476
Cause Menu
480
Alphabetic Groups Menu
481
No
Cause subgroup?
Yes
473
System Screening Questions
474
Serious condition exists?
Yes
No
477
Cause Screening Questions
482
Enter Catalog Number
478
Serious condition exists?
Yes
No
479
Complaint Menu
475
Complaint Menu
483
Initial Problem Screening Questions
484
Serious Medical Condition Exists?
Yes
No
486
Advise Patient to seek immediate Medical Attention
488
End Evaluation Process
490
Is the Re-enter flag raised for this problem?
Yes
No
492
Branch to a Re-enter point in the Evaluation Process
496
B
494
A

Fig. 10a

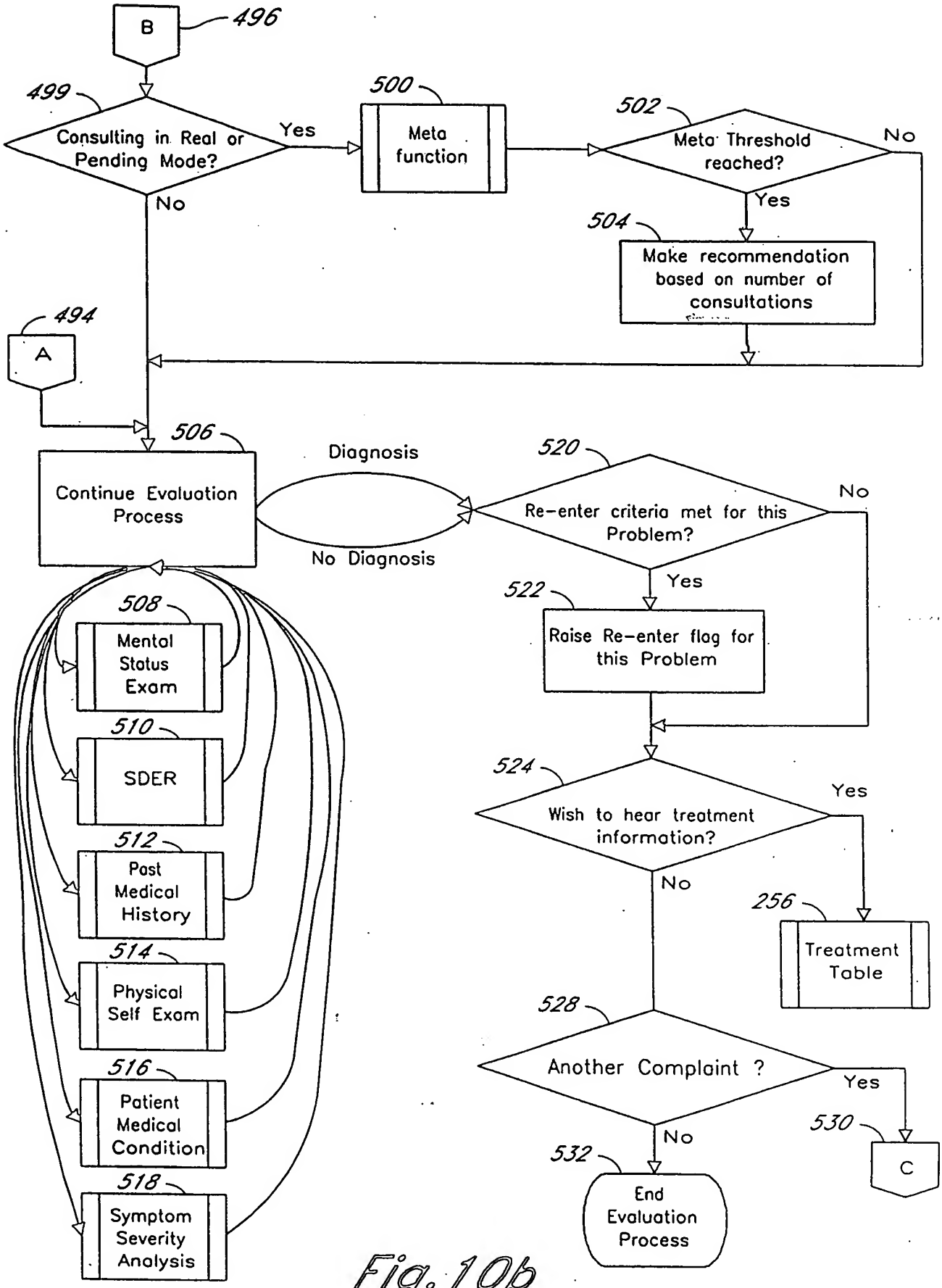
B
496
499
Consulting in Real or Pending Mode?
Yes
No
500
Meta function
502
Meta Threshold reached?
No
Yes
504
Make recommendation based on number of consultations
494
A
506
Continue Evaluation Process
Diagnosis
No Diagnosis
520
Re-enter criteria met for this Problem?
No
Yes
522
Raise Re-enter flag for this Problem
508
Mental Status Exam
510
SDER
512
Past Medical History
514
Physical Self Exam
516
Patient Medical Condition
518
Symptom Severity Analysis
524
Wish to hear treatment information?
Yes
No
256
Treatment Table
528
Another Complaint ?
Yes
No
530
C
532
End Evaluation Process

Fig. 10b

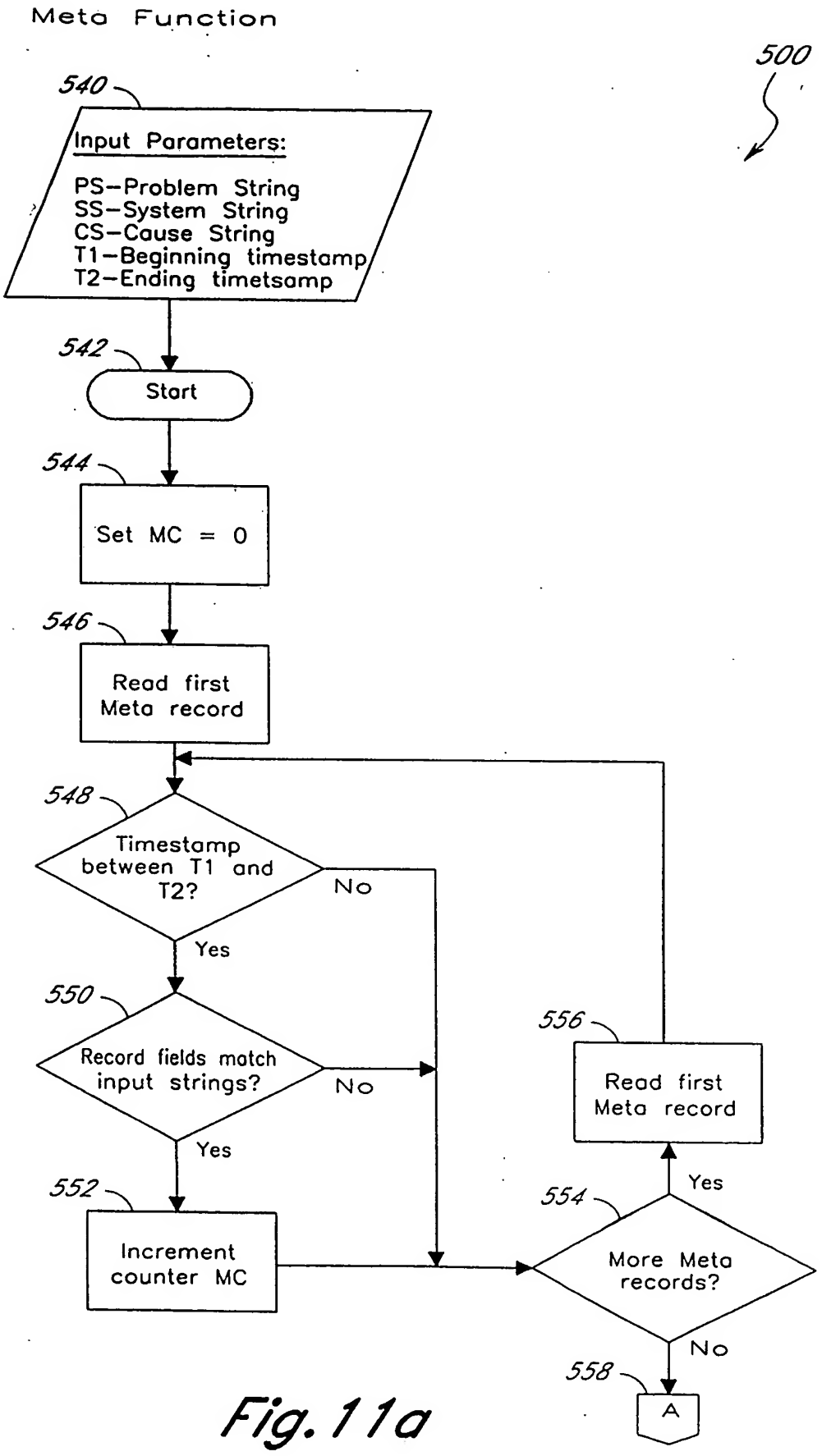
Meta Function
500
540
Input Parameters:
PS–Problem String
SS–System String
CS–Cause String
T1–Beginning timestamp
T2–Ending timetsamp
542
Start
544
Set MC = 0
546
Read first Meta record
548
Timestamp between T1 and T2?
No
Yes
550
Record fields match input strings?
No
Yes
552
Increment counter MC
554
More Meta records?
Yes
No
556
Read first Meta record
558
A

Fig. 11a

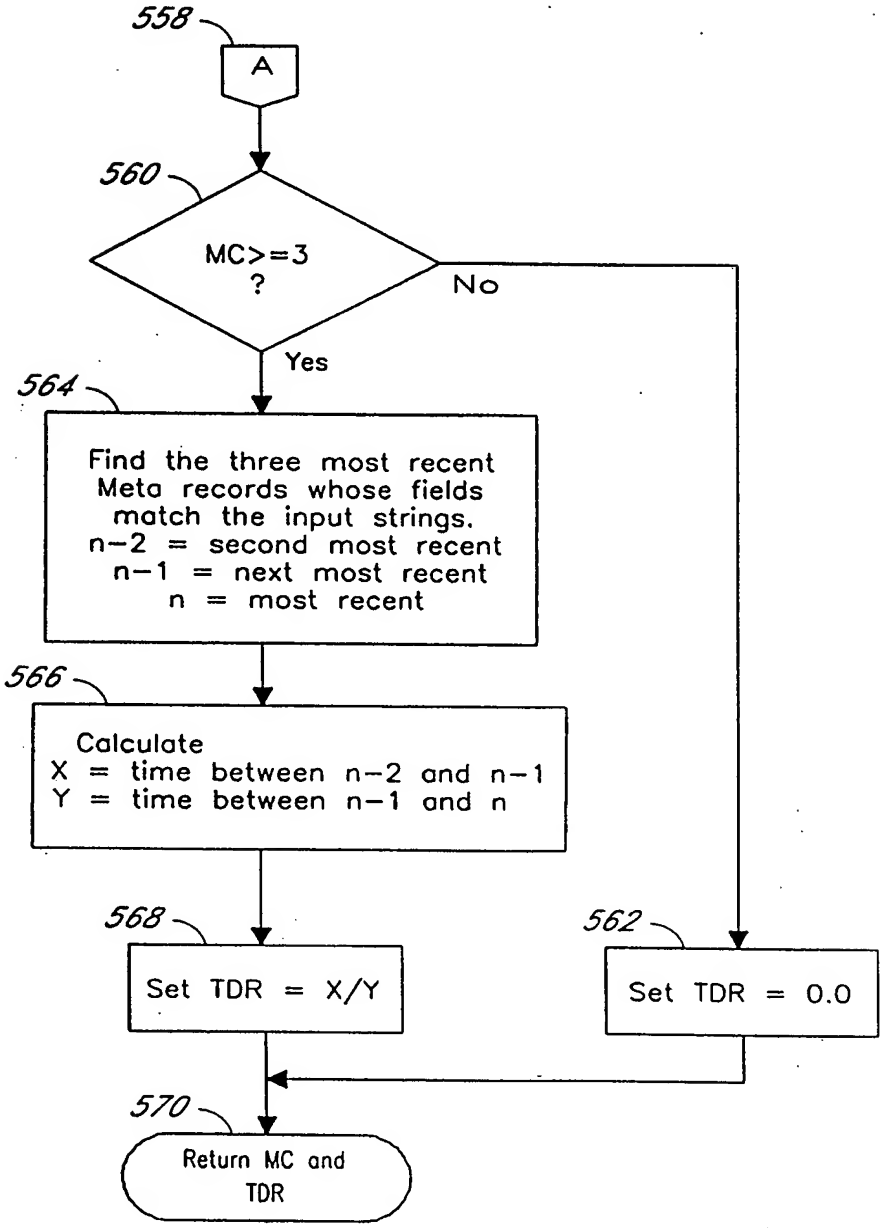
558
A
560
MC>=3
?
No
Yes
564
Find the three most recent Meta records whose fields match the input strings.
n−2 = second most recent
n−1 = next most recent
n = most recent
566
Calculate
X = time between n−2 and n−1
Y = time between n−1 and n
568
Set TDR = X/Y
562
Set TDR = 0.0
570
Return MC and TDR

Fig. 11b

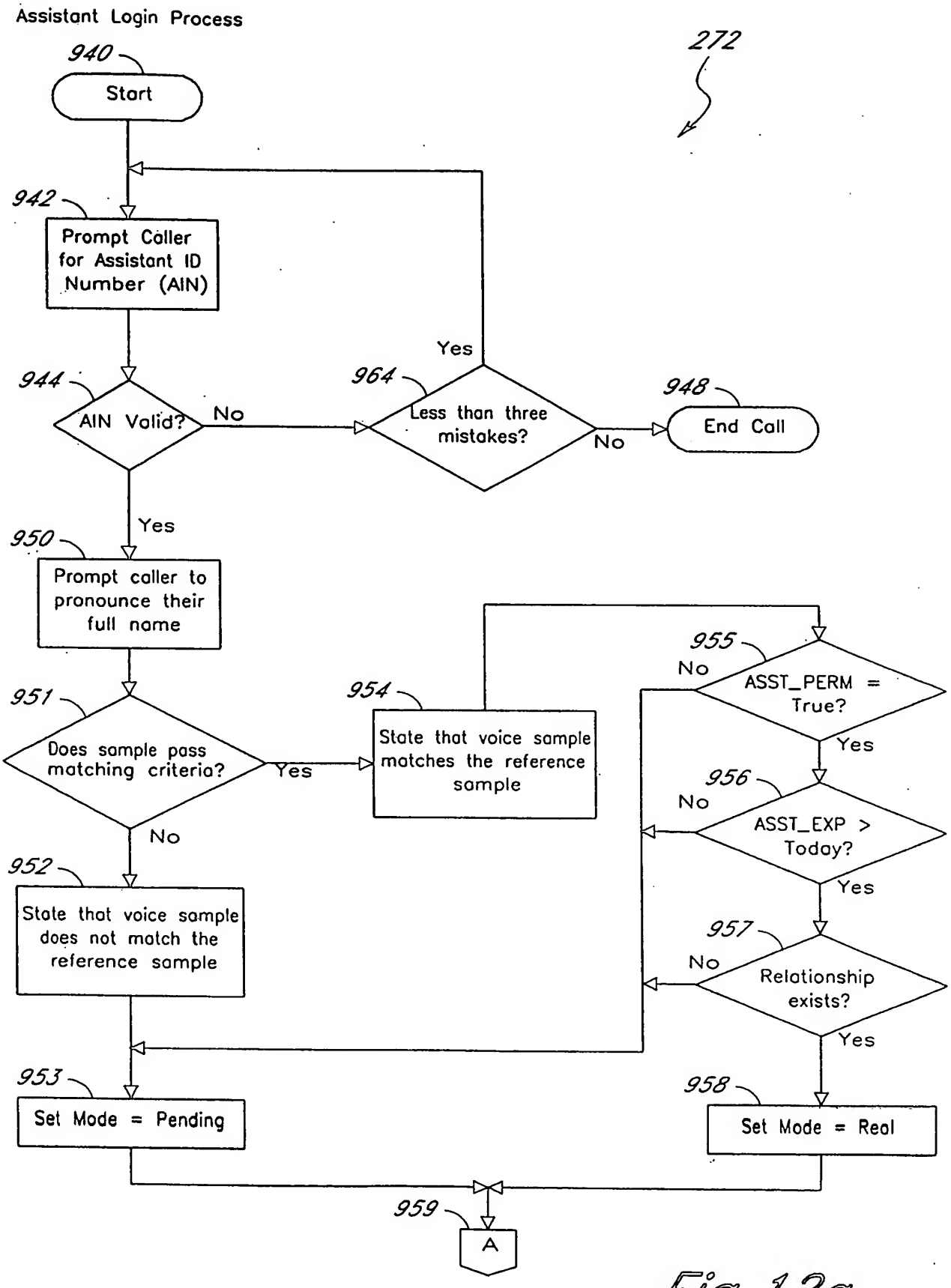
Assistant Login Process
272
940
Start
942
Prompt Caller for Assistant ID Number (AIN)
944
AIN Valid?
No
964
Less than three mistakes?
Yes
No
948
End Call
Yes
950
Prompt caller to pronounce their full name
951
Does sample pass matching criteria?
Yes
954
State that voice sample matches the reference sample
No
952
State that voice sample does not match the reference sample
955
ASST_PERM = True?
No
Yes
956
ASST_EXP > Today?
No
Yes
957
Relationship exists?
No
Yes
953
Set Mode = Pending
958
Set Mode = Real
959
A

Fig. 12a

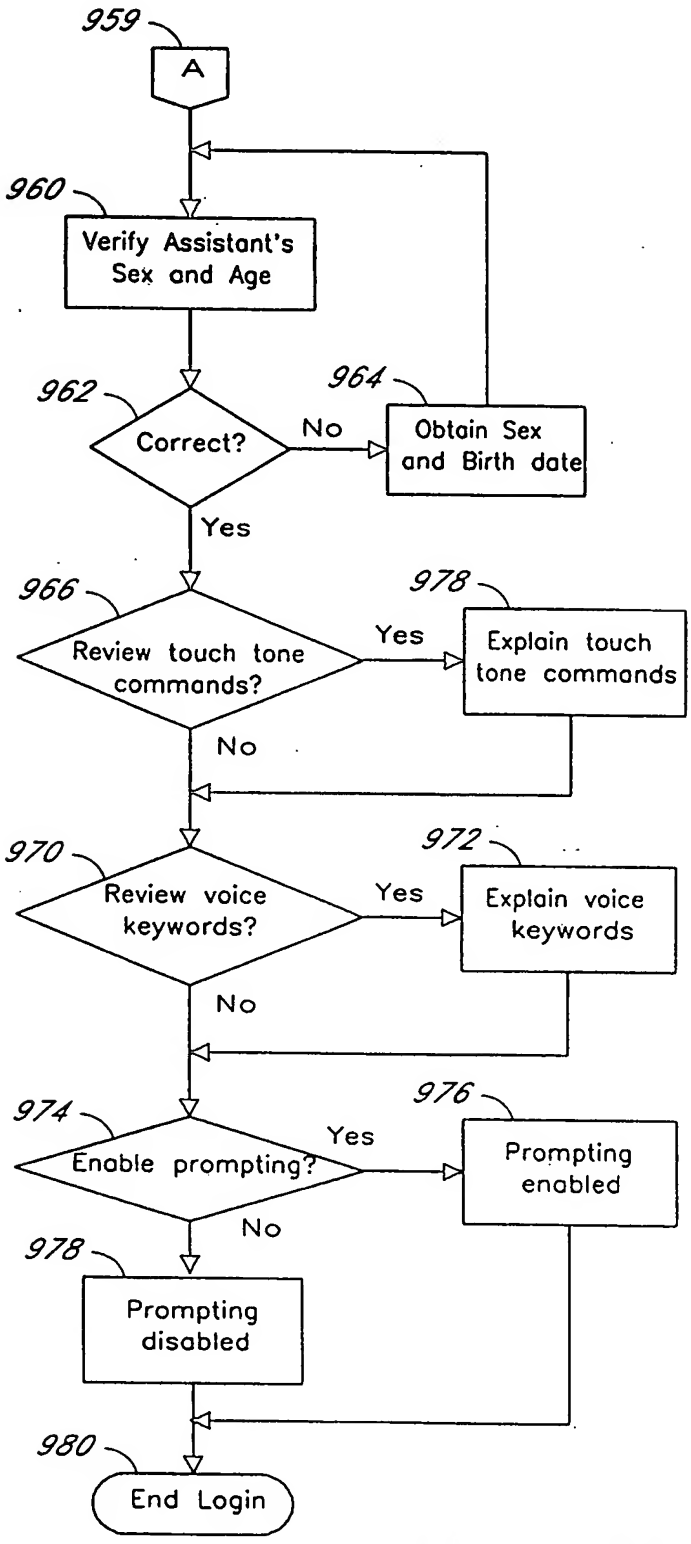
959
A
960
Verify Assistant's Sex and Age
962
Correct?
No
964
Obtain Sex and Birth date
Yes
966
Review touch tone commands?
Yes
978
Explain touch tone commands
No
970
Review voice keywords?
Yes
972
Explain voice keywords
No
974
Enable prompting?
Yes
976
Prompting enabled
No
978
Prompting disabled
980
End Login

Fig. 12b

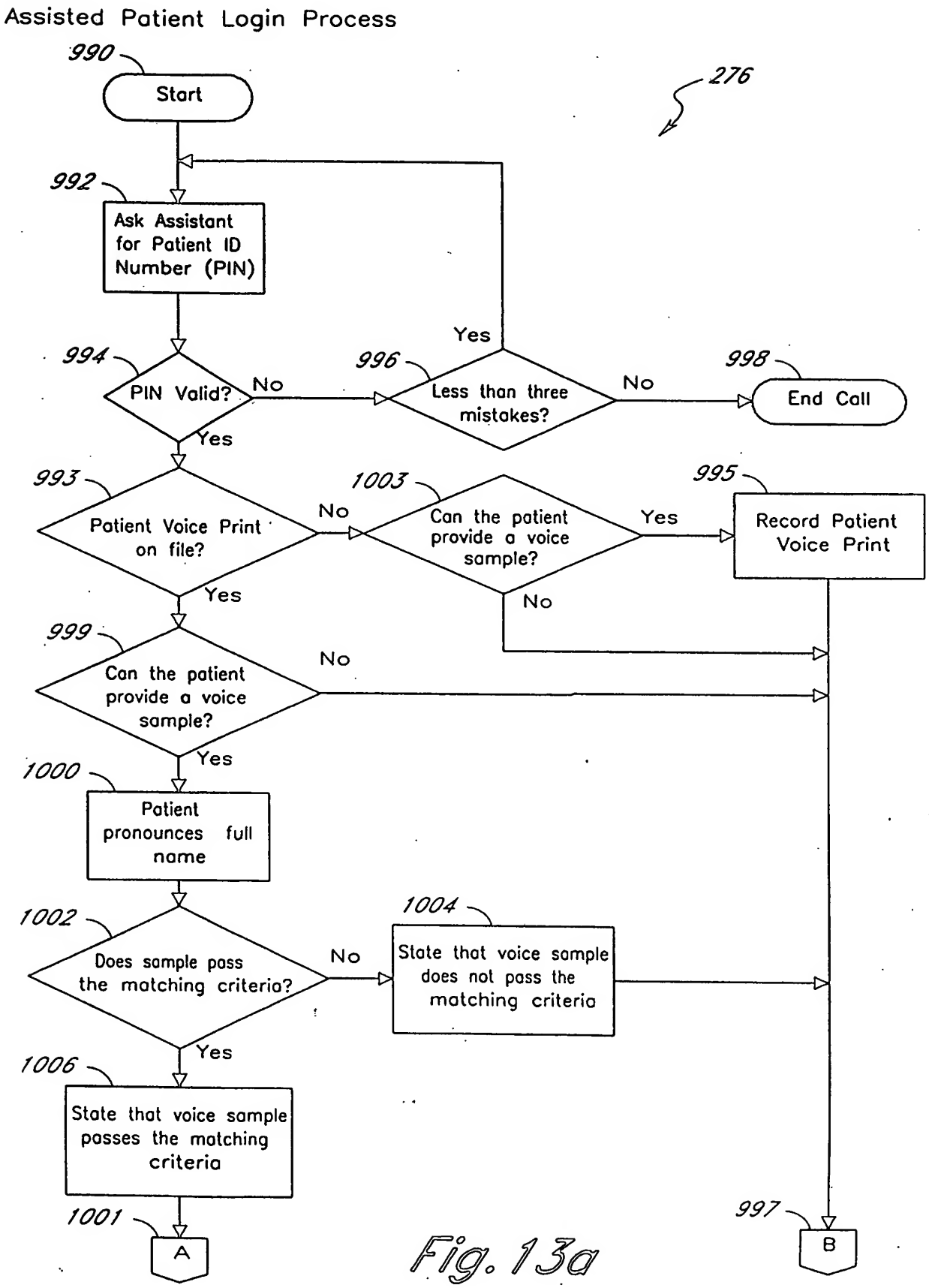
Assisted Patient Login Process
990
Start
276
992
Ask Assistant for Patient ID Number (PIN)
994
PIN Valid?
No
Yes
996
Less than three mistakes?
Yes
No
998
End Call
993
Patient Voice Print on file?
No
Yes
1003
Can the patient provide a voice sample?
Yes
No
995
Record Patient Voice Print
999
Can the patient provide a voice sample?
No
Yes
1000
Patient pronounces full name
1002
Does sample pass the matching criteria?
No
Yes
1004
State that voice sample does not pass the matching criteria
1006
State that voice sample passes the matching criteria
1001
A
997
B

Fig. 13a

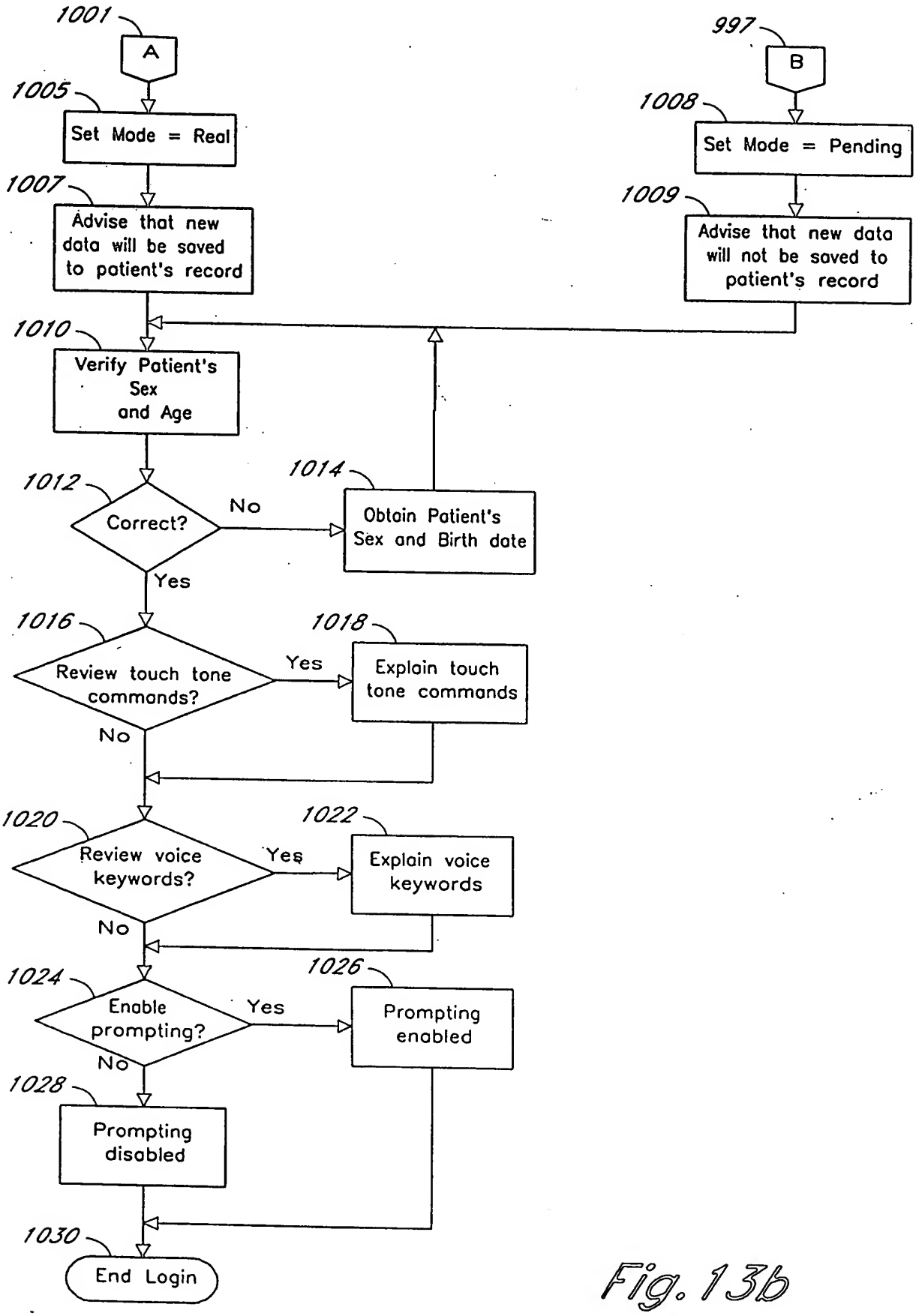
1001
A
997
B
1005
Set Mode = Real
1008
Set Mode = Pending
1007
Advise that new data will be saved to patient's record
1009
Advise that new data will not be saved to patient's record
1010
Verify Patient's Sex and Age
1012
Correct?
No
1014
Obtain Patient's Sex and Birth date
Yes
1016
Review touch tone commands?
Yes
1018
Explain touch tone commands
No
1020
Review voice keywords?
Yes
1022
Explain voice keywords
No
1024
Enable prompting?
Yes
1026
Prompting enabled
No
1028
Prompting disabled
1030
End Login

Fig. 13b

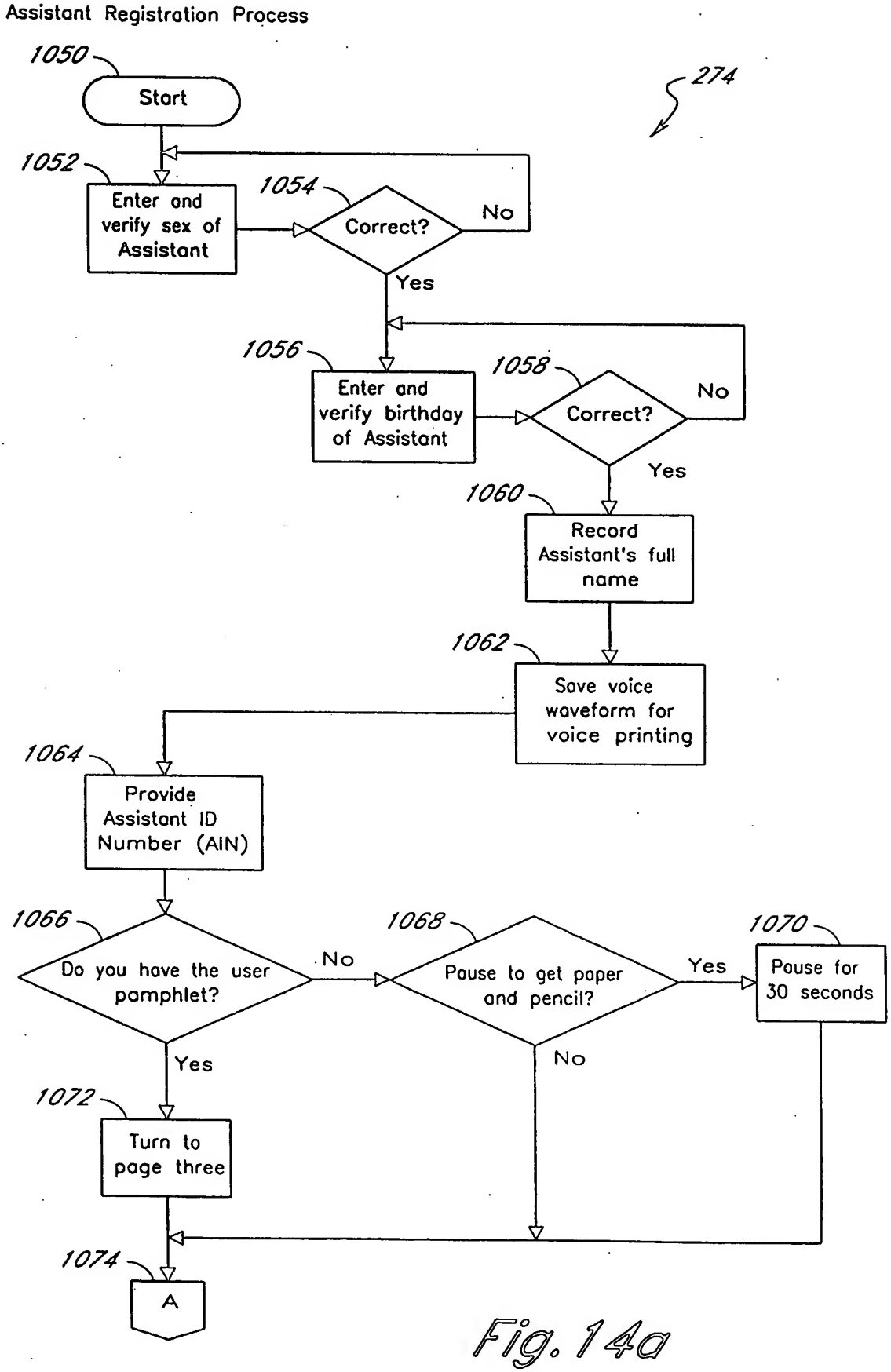
Assistant Registration Process
1050
Start
274
1052
Enter and verify sex of Assistant
1054
Correct?
No
Yes
1056
Enter and verify birthday of Assistant
1058
Correct?
No
Yes
1060
Record Assistant's full name
1062
Save voice waveform for voice printing
1064
Provide Assistant ID Number (AIN)
1066
Do you have the user pamphlet?
No
Yes
1068
Pause to get paper and pencil?
Yes
No
1070
Pause for 30 seconds
1072
Turn to page three
1074
A

Fig. 14a

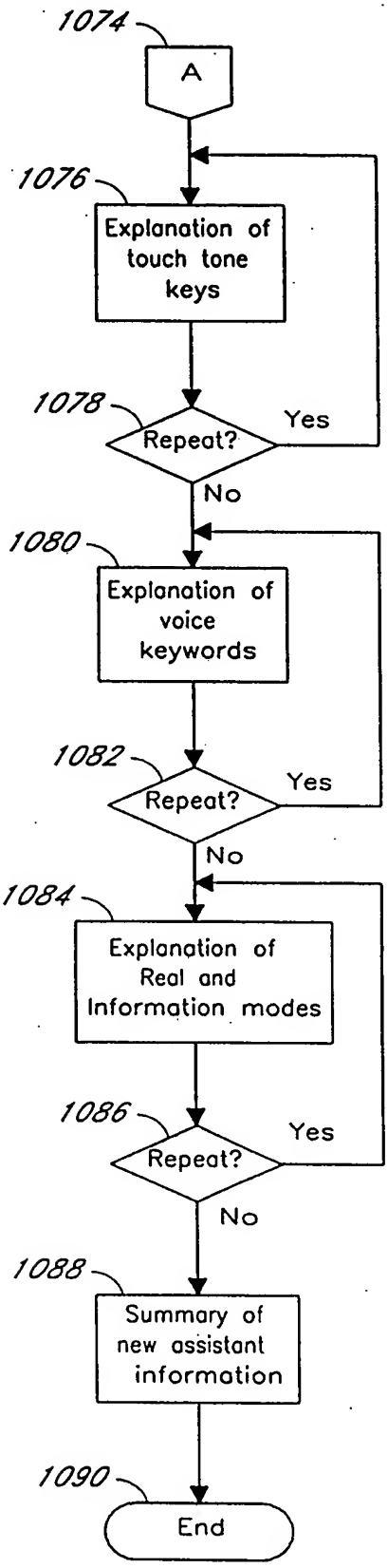
1074
A
1076
Explanation of touch tone keys
1078
Repeat?
Yes
No
1080
Explanation of voice keywords
1082
Repeat?
Yes
No
1084
Explanation of Real and Information modes
1086
Repeat?
Yes
No
1088
Summary of new assistant information
1090
End

Fig. 14b

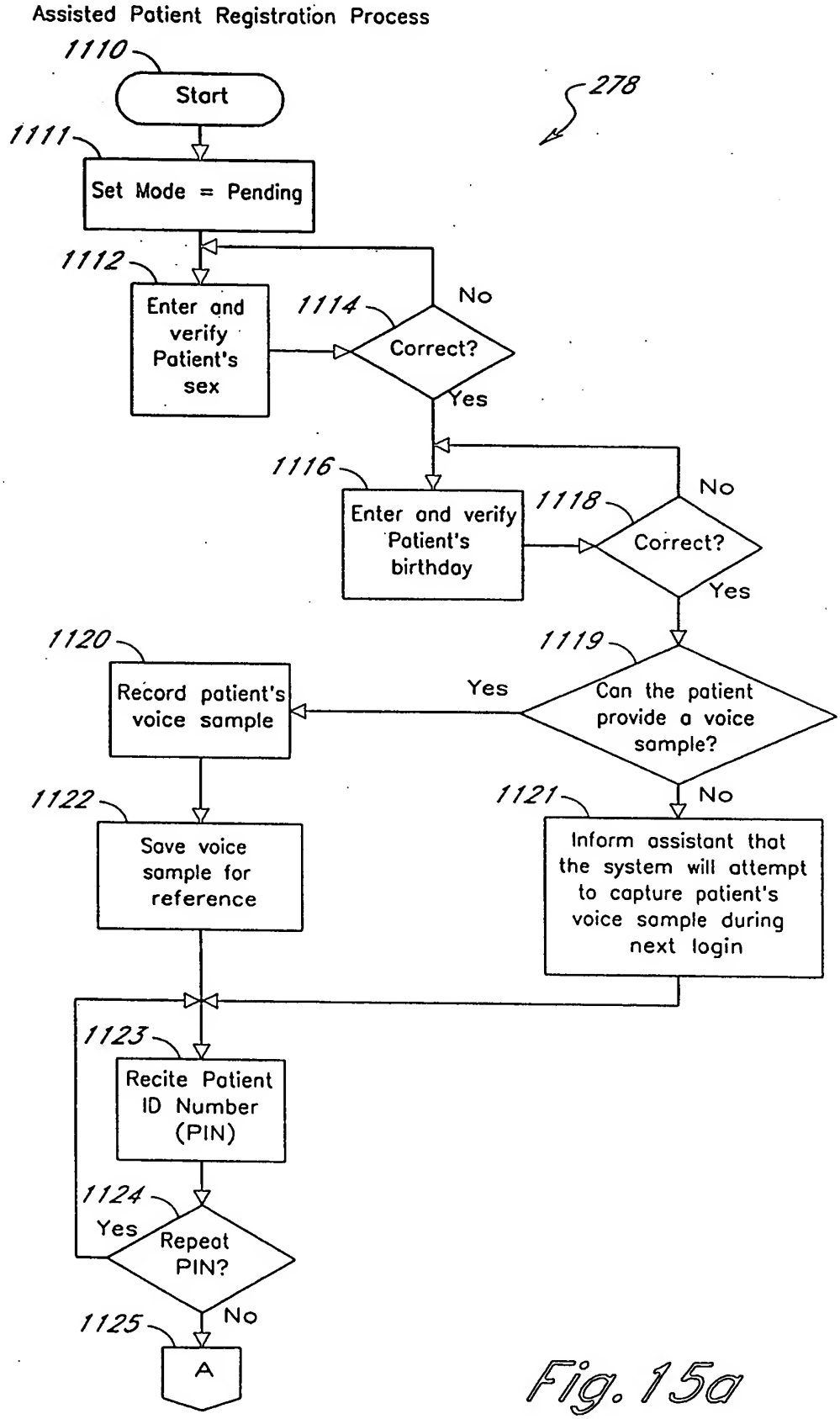
Assisted Patient Registration Process
1110
Start
278
1111
Set Mode = Pending
1112
Enter and verify Patient's sex
1114
Correct?
No
Yes
1116
Enter and verify Patient's birthday
1118
Correct?
No
Yes
1119
Can the patient provide a voice sample?
Yes
No
1120
Record patient's voice sample
1121
Inform assistant that the system will attempt to capture patient's voice sample during next login
1122
Save voice sample for reference
1123
Recite Patient ID Number (PIN)
1124
Repeat PIN?
Yes
No
1125
A

Fig. 15a

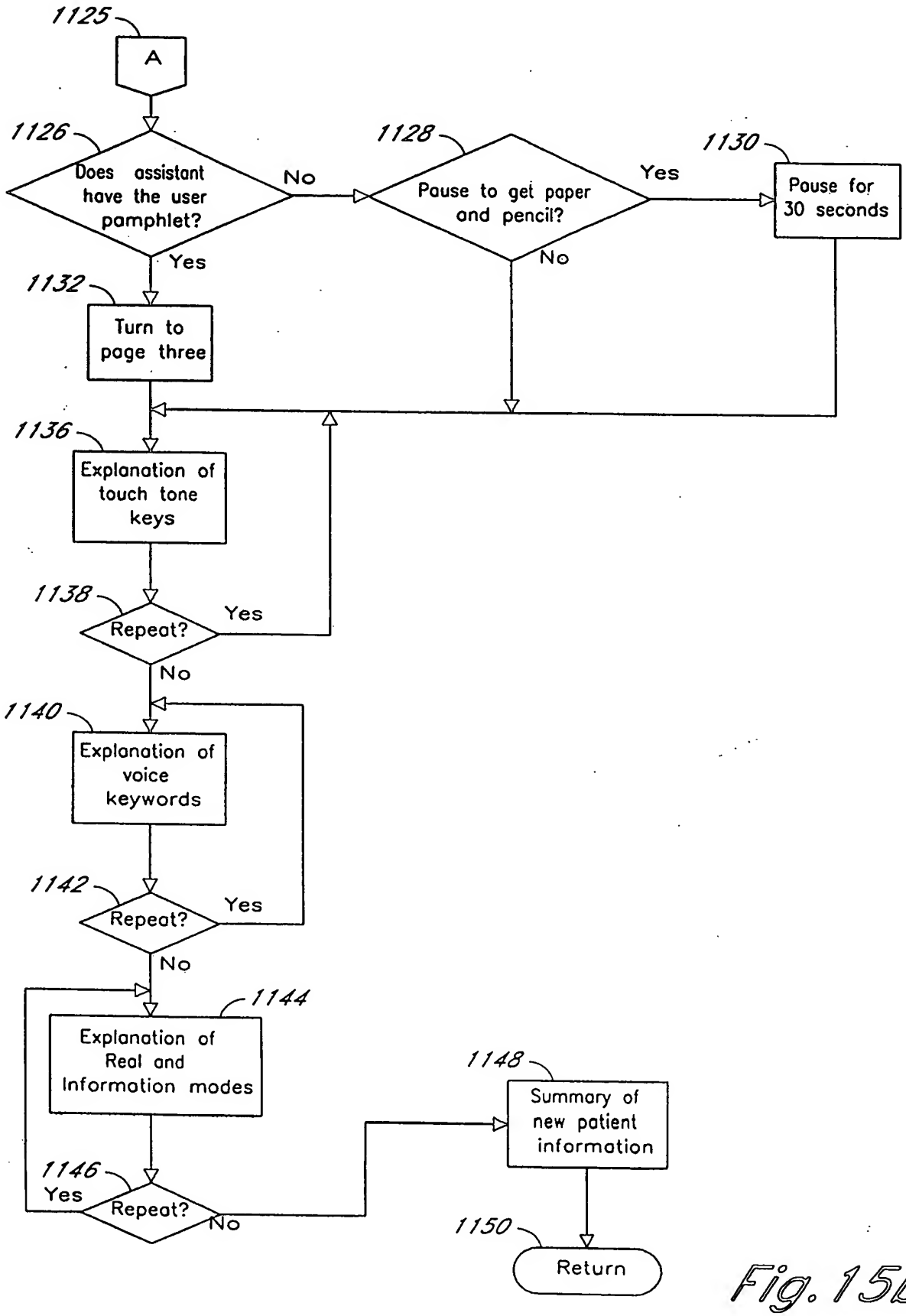
1125
A
1126
Does assistant have the user pamphlet?
No
1128
Pause to get paper and pencil?
Yes
1130
Pause for 30 seconds
Yes
No
1132
Turn to page three
1136
Explanation of touch tone keys
1138
Repeat?
Yes
No
1140
Explanation of voice keywords
1142
Repeat?
Yes
No
1144
Explanation of Real and Information modes
1146
Yes
Repeat?
No
1148
Summary of new patient information
1150
Return

Fig. 15b

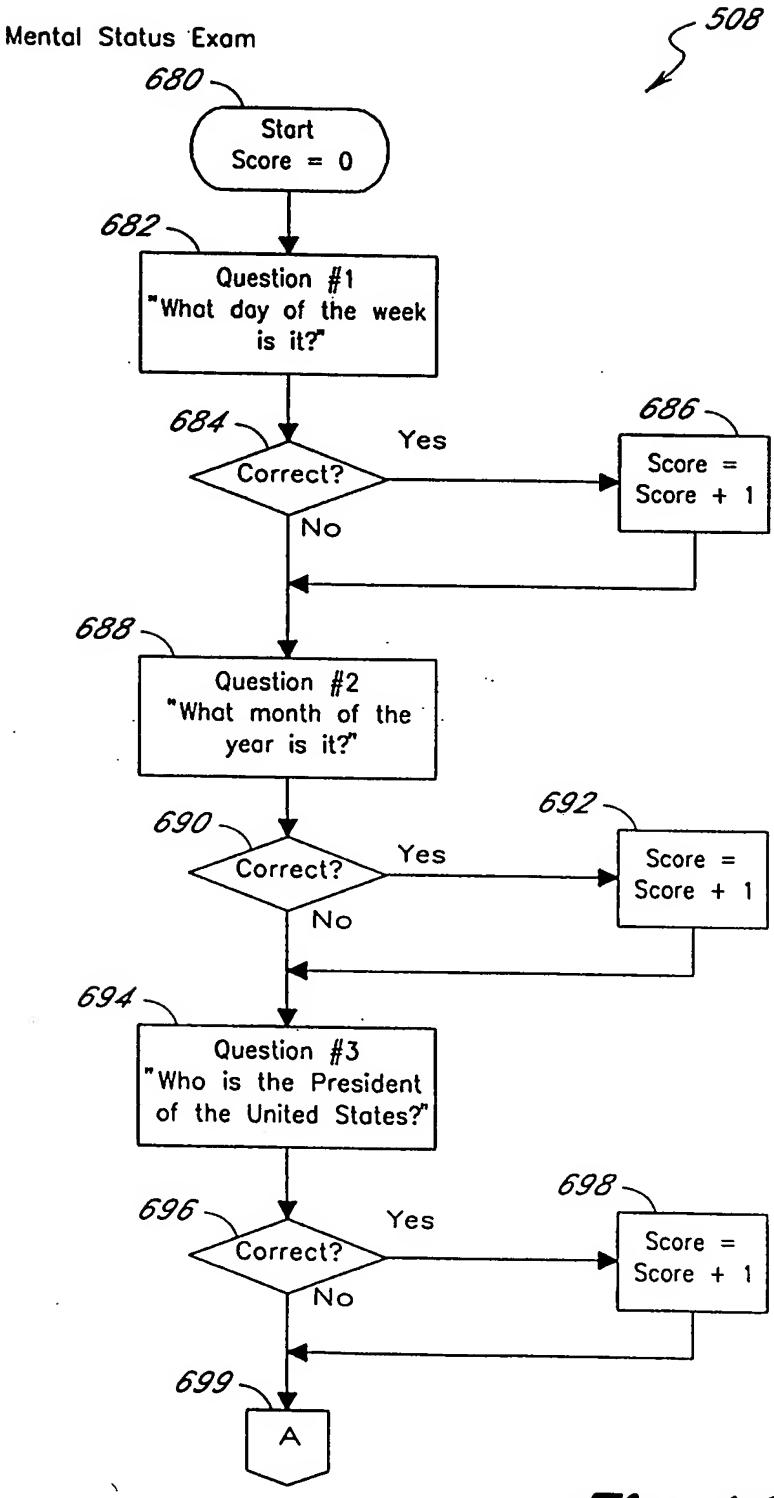
Mental Status Exam
508
680
Start
Score = 0
682
Question #1
"What day of the week is it?"
684
Correct?
Yes
No
686
Score = Score + 1
688
Question #2
"What month of the year is it?"
690
Correct?
Yes
No
692
Score = Score + 1
694
Question #3
"Who is the President of the United States?"
696
Correct?
Yes
No
698
Score = Score + 1
699
A

Fig. 16a

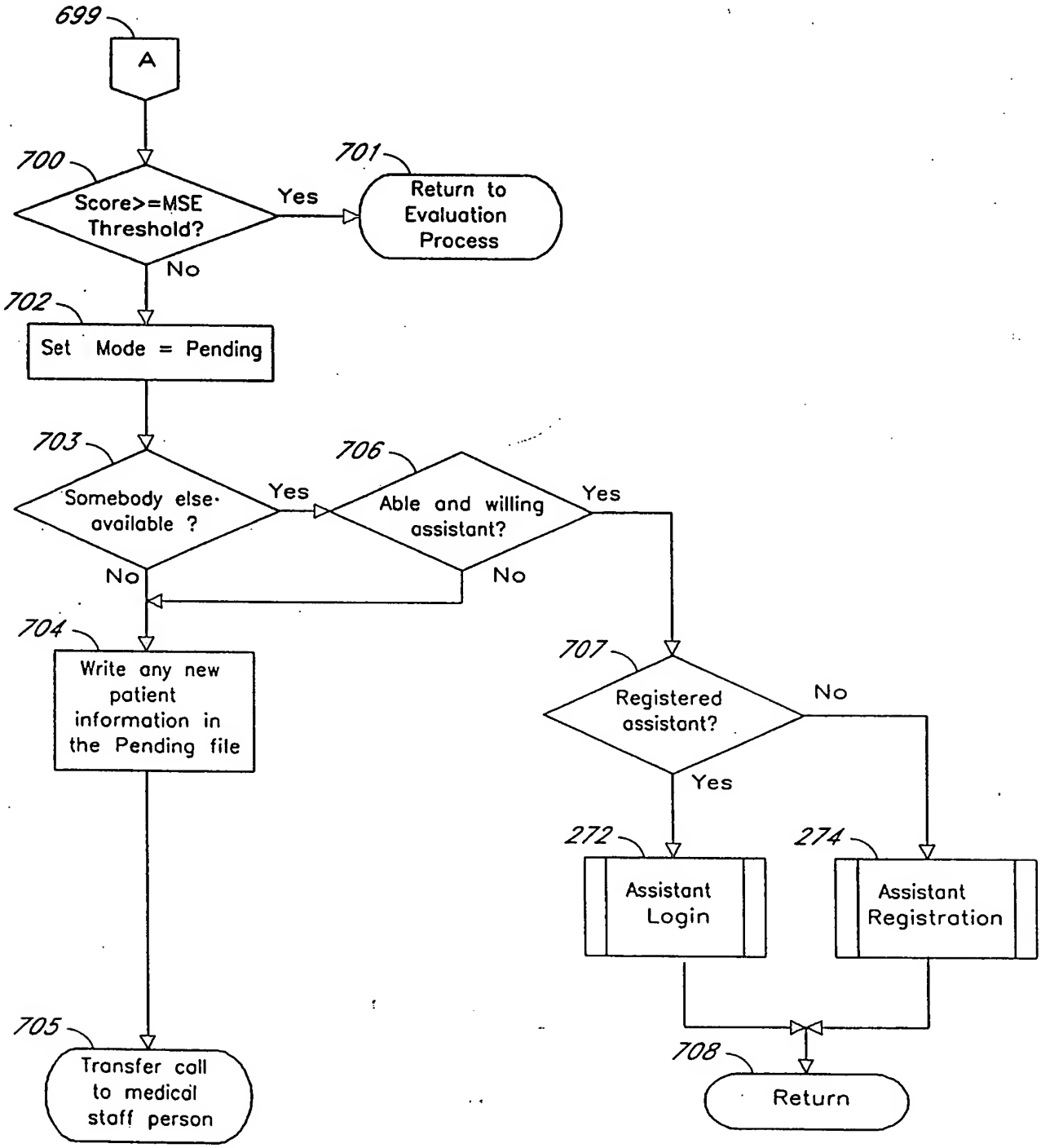
699
A
700
Score>=MSE Threshold?
Yes
701
Return to Evaluation Process
No
702
Set Mode = Pending
703
Somebody else available ?
Yes
706
Able and willing assistant?
Yes
No
No
704
Write any new patient information in the Pending file
707
Registered assistant?
No
Yes
272
Assistant Login
274
Assistant Registration
705
Transfer call to medical staff person
708
Return

Fig. 16b

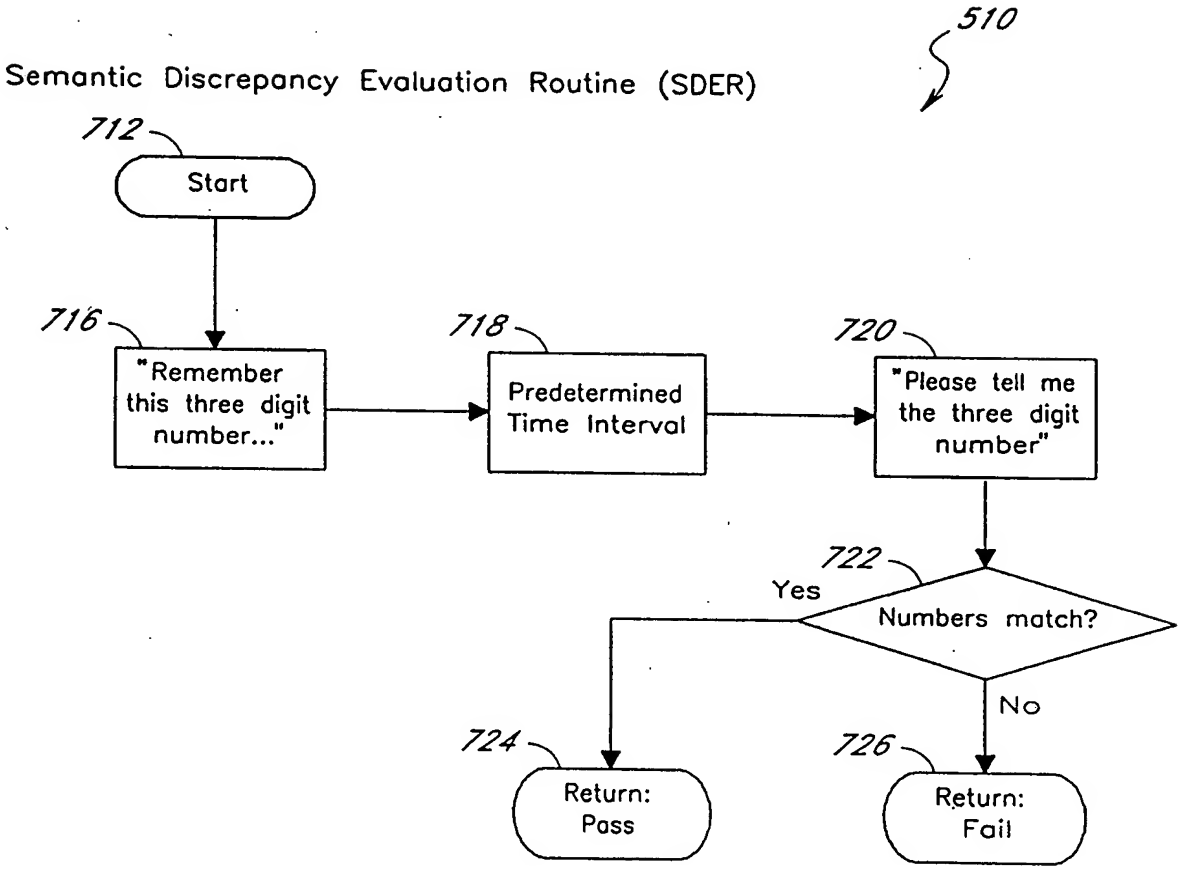
510
Semantic Discrepancy Evaluation Routine (SDER)
712
Start
716
"Remember this three digit number..."
718
Predetermined Time Interval
720
"Please tell me the three digit number"
722
Yes
Numbers match?
No
724
Return: Pass
726
Return: Fail

Fig. 17

Past Medical History Routine

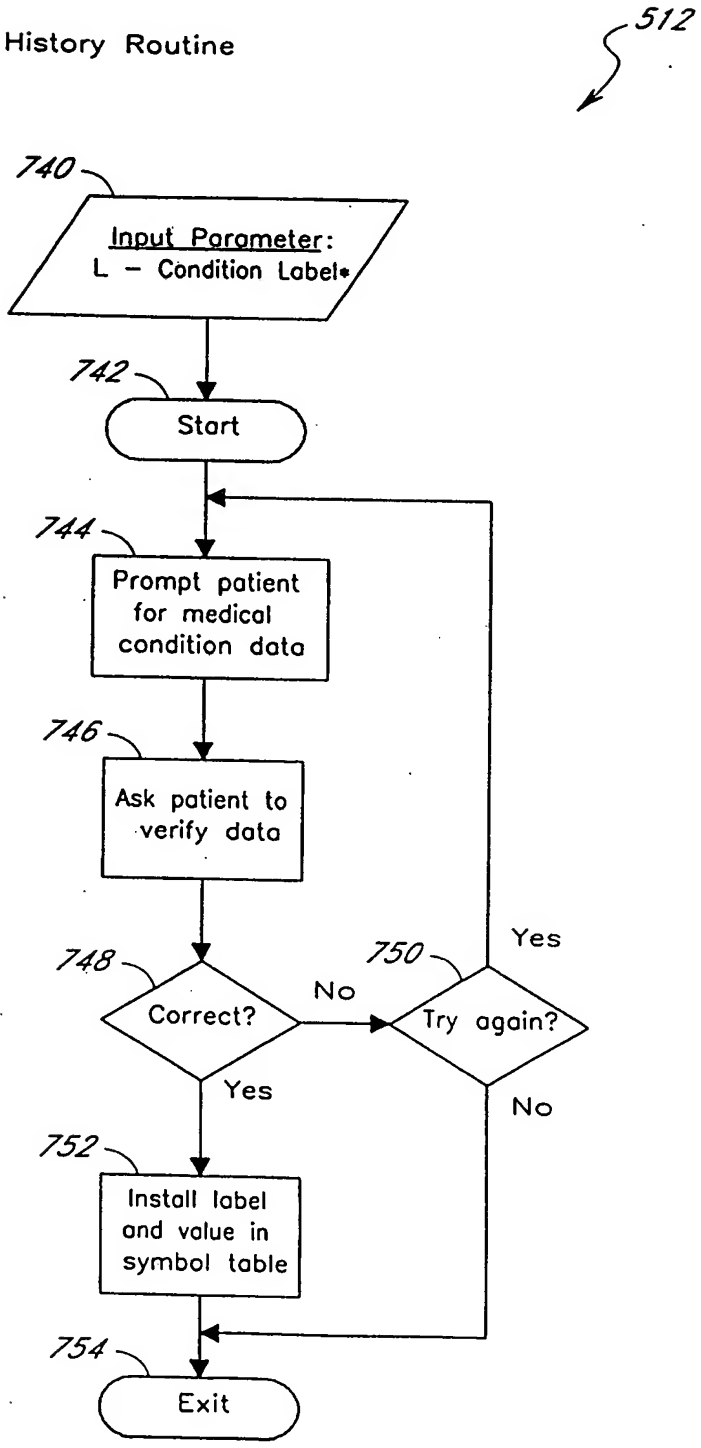

Fig. 18

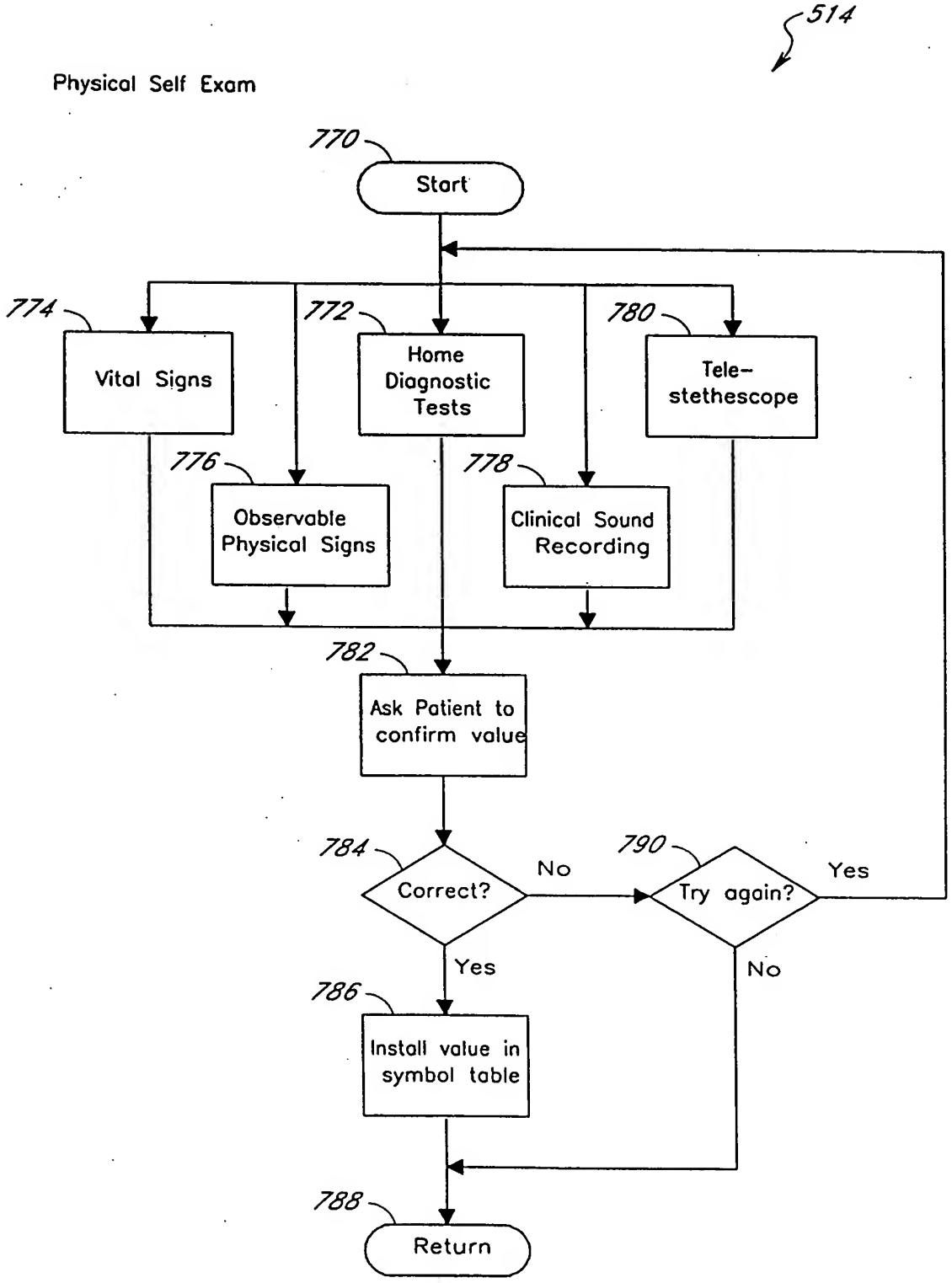
514
Physical Self Exam
770
Start
774
Vital Signs
772
Home Diagnostic Tests
780
Tele-stethescope
776
Observable Physical Signs
778
Clinical Sound Recording
782
Ask Patient to confirm value
784
Correct?
No
790
Try again?
Yes
Yes
No
786
Install value in symbol table
788
Return

Fig. 19

Patient Medical Condition Routine

516

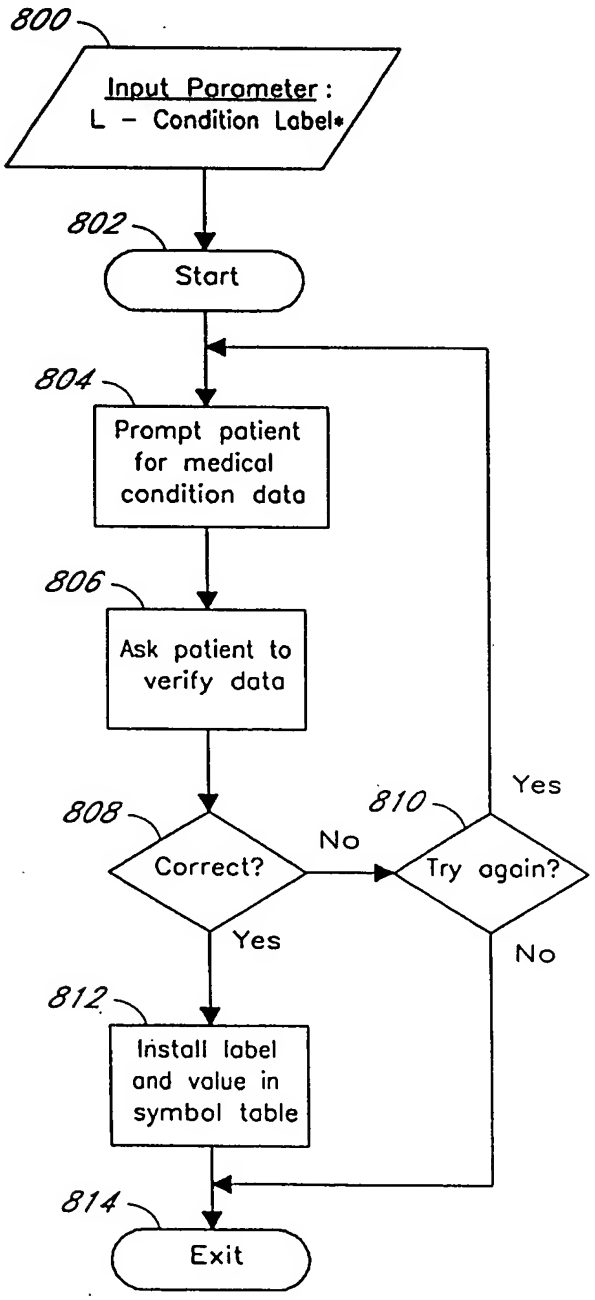

Fig.20

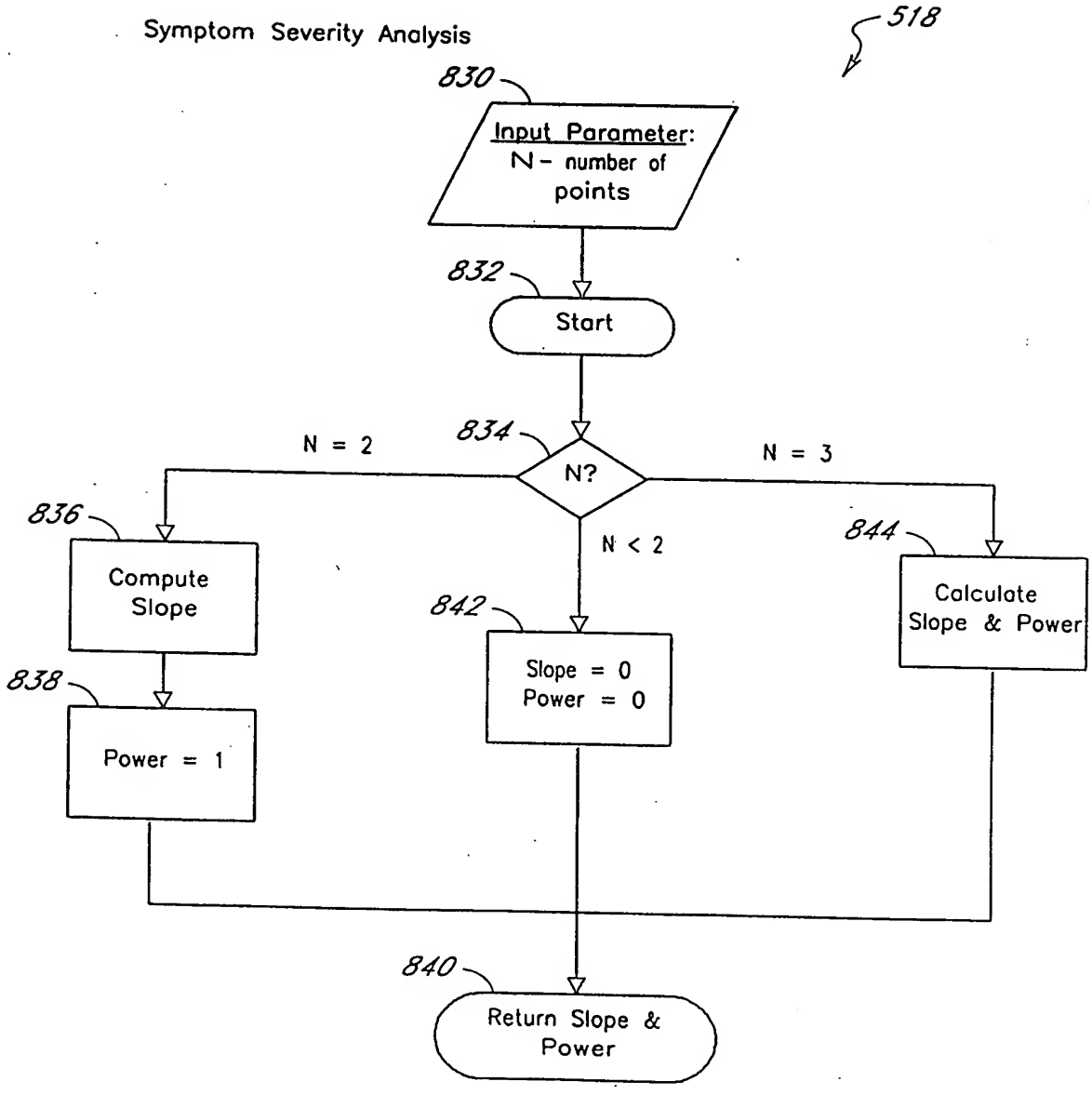
Symptom Severity Analysis
518
830
Input Parameter:
N - number of points
832
Start
834
N?
N = 2
N = 3
N < 2
836
Compute Slope
838
Power = 1
842
Slope = 0
Power = 0
844
Calculate Slope & Power
840
Return Slope & Power

Fig. 21

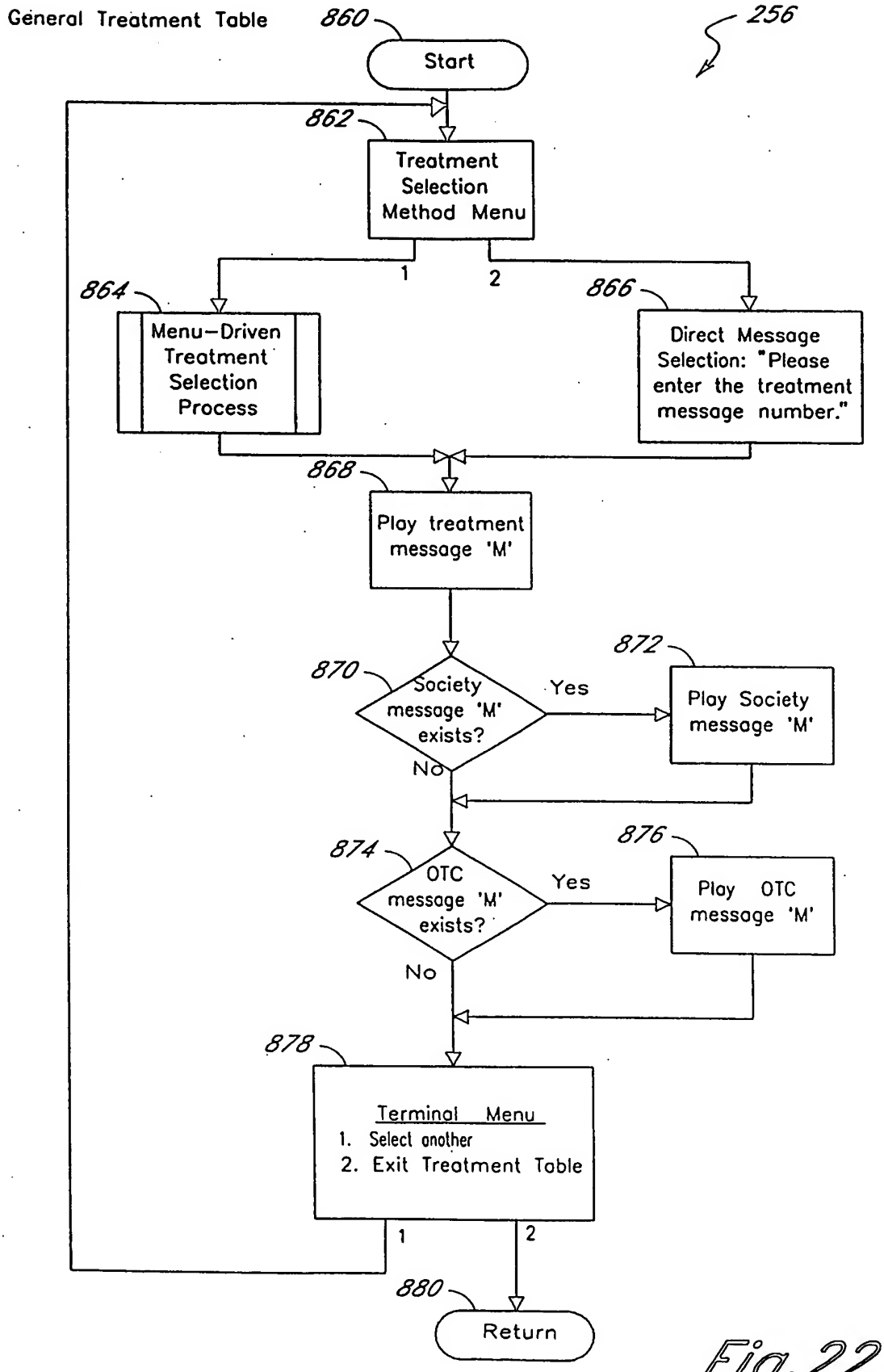
General Treatment Table
860
256
Start
862
Treatment Selection Method Menu
1
2
864
Menu-Driven Treatment Selection Process
866
Direct Message Selection: "Please enter the treatment message number."
868
Play treatment message 'M'
870
Society message 'M' exists?
Yes
No
872
Play Society message 'M'
874
OTC message 'M' exists?
Yes
No
876
Play OTC message 'M'
878
Terminal Menu
1. Select another
2. Exit Treatment Table
1
2
880
Return

Fig. 22

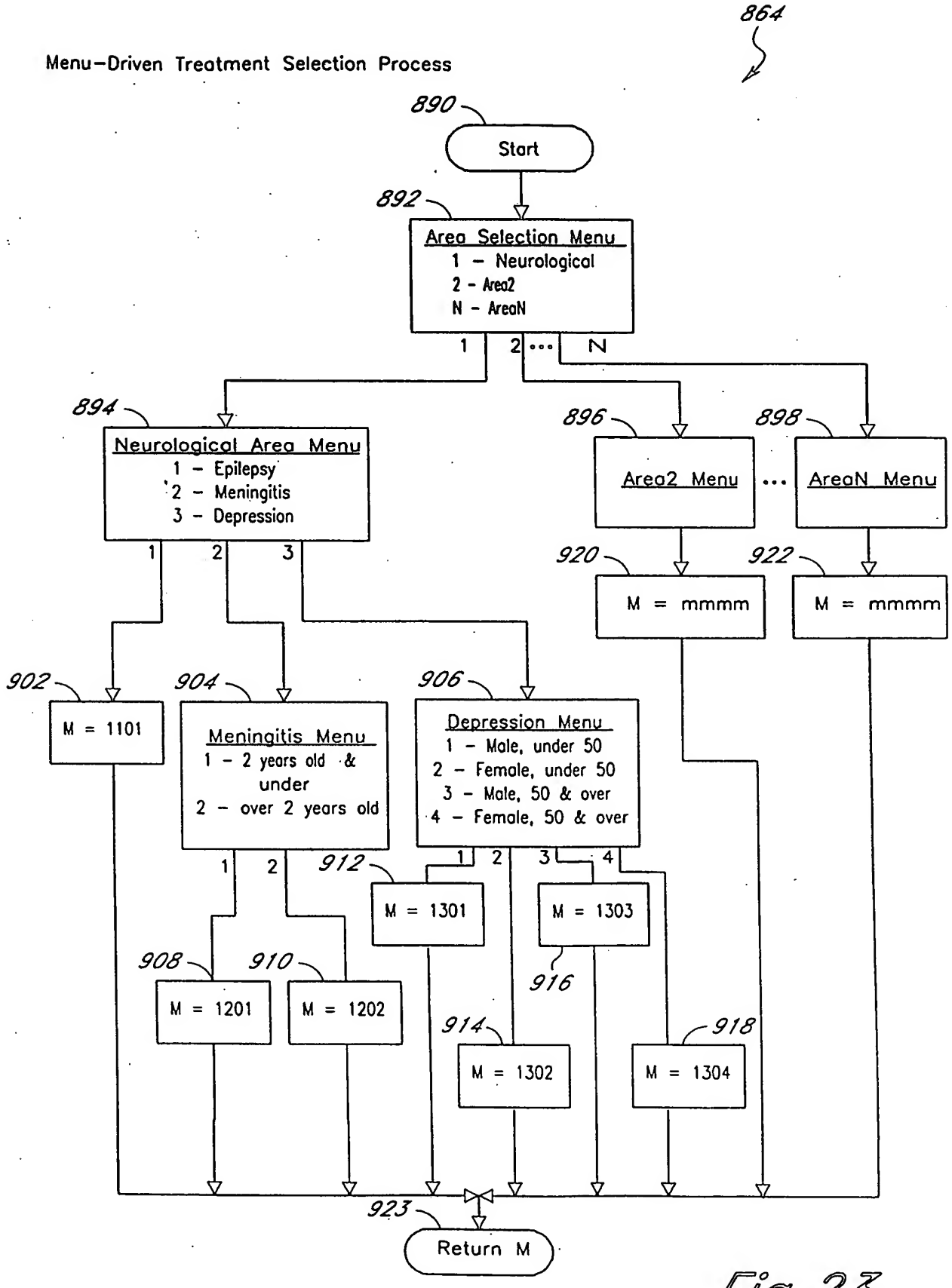
864
Menu-Driven Treatment Selection Process
890
Start
892
Area Selection Menu
1 - Neurological
2 - Area2
N - AreaN
1
2
N
894
Neurological Area Menu
1 - Epilepsy
2 - Meningitis
3 - Depression
896
Area2 Menu
898
AreaN Menu
920
M = mmmm
922
M = mmmm
902
M = 1101
904
Meningitis Menu
1 - 2 years old & under
2 - over 2 years old
906
Depression Menu
1 - Male, under 50
2 - Female, under 50
3 - Male, 50 & over
4 - Female, 50 & over
912
M = 1301
M = 1303
916
908
M = 1201
910
M = 1202
914
M = 1302
918
M = 1304
923
Return M

Fig. 23

TABLE 3

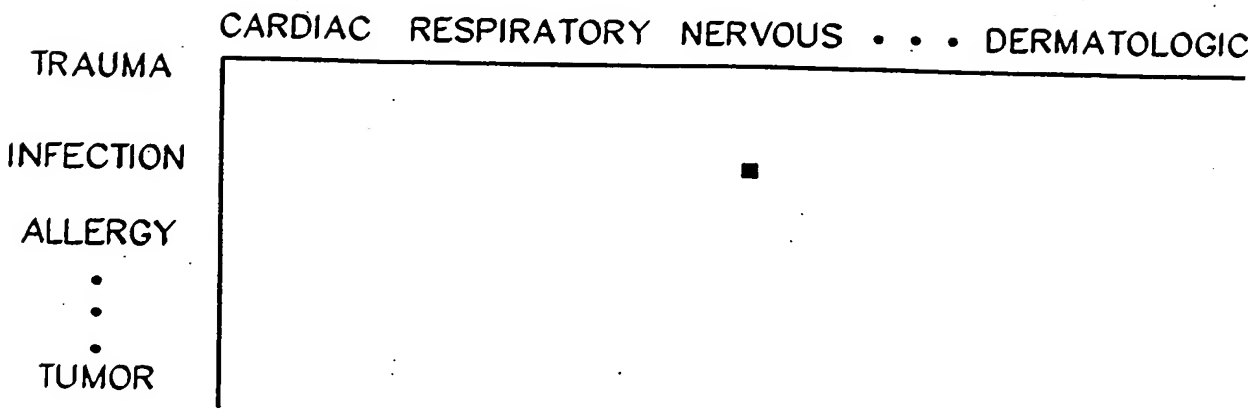

FIG. 24

TABLE 4

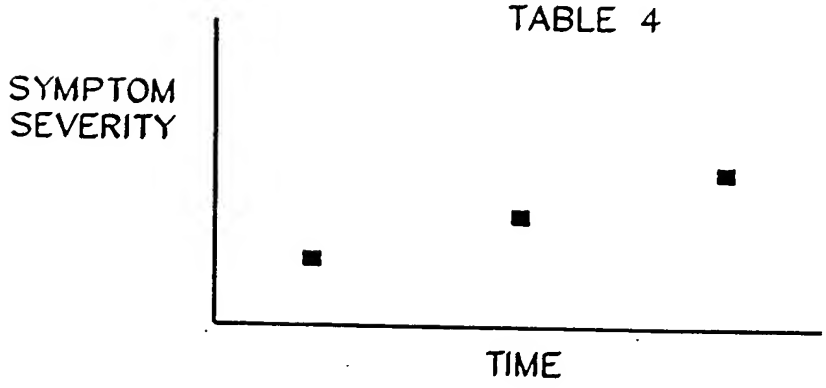

FIG. 25

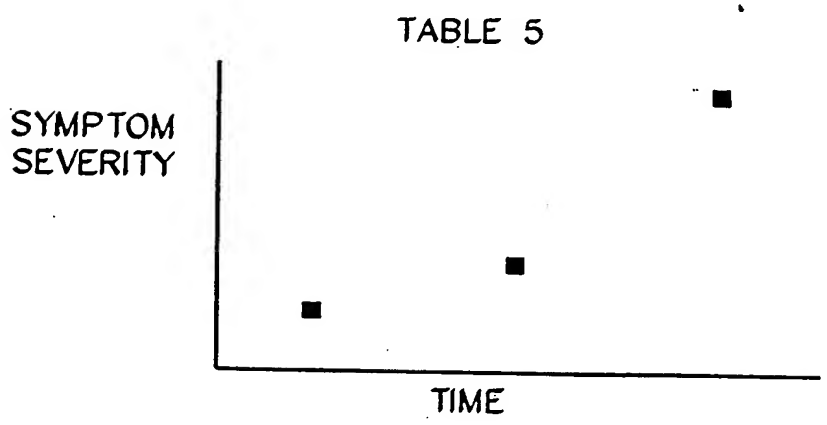
TABLE 5
SYMPTOM SEVERITY
TIME

FIG. 26

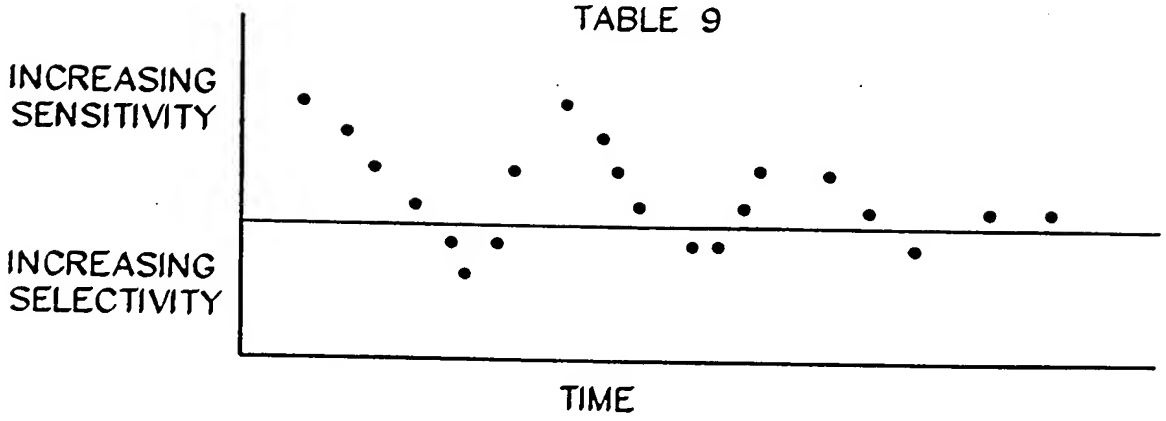
TABLE 9
INCREASING SENSITIVITY
INCREASING SELECTIVITY
TIME

FIG. 27